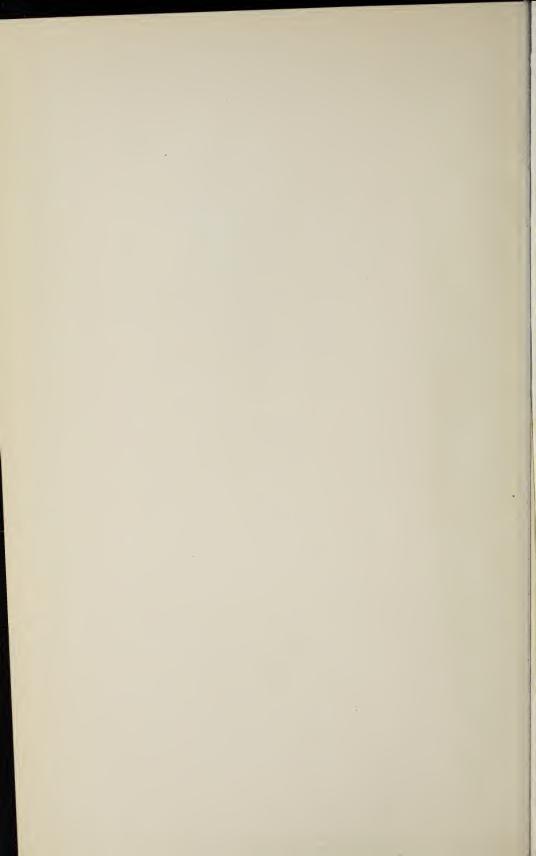


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PLECOPTERA NYMPHS
OF AMERICA
(NORTH OF MEXICO)

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9

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PERLA CAPITATA

PLECOPTERA NYMPHS OF AMERICA

(NORTH OF MEXICO)

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PROFESSOR OF BIOLOGY
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PUBLISHED FOR

THE THOMAS SAY FOUNDATION

 $\mathbf{B}\mathbf{Y}$

CHARLES C THOMAS · PUBLISHER

SPRINGFIELD · ILLINOIS

BALTIMORE · MARYLAND

1931

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> 432.5 C583 p AGRI-CULTURAL

THE INVESTIGATION upon which this volume is based was in part supported by a grant from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University.

PLECOPTERA NYMPHS
OF AMERICA
(NORTH OF MEXICO)

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INTRODUCTION

THE first American stoneny nymph and 25 (34) in 1851 when he published a brief description and an THE first American stonefly nymph was recorded by Newport¹ excellent figure of Pteronarcys regalis=Pt. dorsata Say. Hagen (8) in 1873 describes, also, the nymph of the above species, and in addition to this, he describes the nymph of Pteronarcys proteus Newm., and mentions the nymph of Pteronarcys californica Newpt., from Logan River, Utah. Needham (24) in 1905 described briefly the nymphs of Isoperla bilineata Say and of Leuctra tenella Prov., and in another paper (23) he mentions the unusual appearance of the nymphs of Peltoperla arcuata Ndm. Garman (7) describes the nymphs of three species: "No. 1," "No. 2," and "No. 3," and illustrates No. 1 and No. 3 with beautiful figures. No. 1 represents Acroneuria, probably arida Hag. No. 2 is not figured, but the description indicates that it is either Isoperla or Alloperla. No. 3 is the nymph of Peltoperla sp. Smith (52) in 1913 published a paper on the biology of Perla immarginata Say in which she describes and figures the nymph of this species, and in 1917 (53) she described the nymphs of the following six species: Pteronarcys dorsata Say, P. californica Newpt., P. proteus Newm., P. biloba Newm., Pteronarcella torosa Smith=P. badia Hag., and Perlodes signata Hag.

Wu (57) in 1923 gives an account of the morphology, ethology, and anatomy of Nemoura vallicularia Wu. This is perhaps the most careful and most complete biological study yet made of any stonefly. Needham and Christensen (29) record the following nymphs from Utah: Pteronarcys californica Newpt., Pteronarcella badia Hag., Acroneuria pacifica Bks., Alloperla pallidula Bks., and Isoperla petersoni Clsn. Seemann (51) records the nymphs of the following four species from California: Pteronarcys princeps Bks., Acroneuria californica Bks., Isoperla 5-punctata Bks., and Isoperla sordida Bks. Frison (6), in his excellent paper on the fall and winter stoneflies of Illinois, describes and figures the nymphs of the following ten species: Taeniopteryx nivalis Fitch, T. parvula Bks., T. (Strophopteryx) fasciata Burm., Allocapnia vivipara Clsn., A. pygmaea Burm., A granulata Clsn., A. forbesi (?) Frison, A. mystica Frison, A. recta Clsn., and Leuctra claasseni Frison. Muttkowsky (21) lists the nymphs of Pteronarcys californica Newpt., Acroneuria pacifica Bks., and Perla verticalis Bks., from Yellowstone Park, with data

on the food habits of these nymphs.

¹ Figures in parentheses refer to the bibliographic citations, page 116.

Since the publication of the Monograph of the Plecoptera of North America by Needham and Claassen (27), the writer has devoted some time to the study of the morphology, biology and taxonomy of the immature forms of stoneflies, and within this paper are embodied the results of this investigation. Descriptions and notes on the nymphs of sixty-eight species are included, and these represent all the genera of the order except Kathroperla, a rare Western genus; Perlyomyia, a very close ally of Leuctra; and Capnura, a genus closely related to Capnia and containing only one known species.

Probably one of the most striking results obtained from the study is the fact that the nymphs of only one family, the Perlidae, are essentially carnivorous, while the nymphs of all other families are herbivorous. Peltoperla, which has heretofore been included in the family Perlidae, is here placed in a separate family, Peltoperlidae. This seems desirable since the nymphs of Peltoperla are true herbivores, and in structural characters differ markedly from the nymphs of any of the other genera now included in the

family Perlidae.

In addition to the many structural characters which have been used in separating genera and species, the color patterns of the nymphs, especially those of the Perlidae, have been found remarkably reliable for use in identifying different species. However, in the Pteronarcidae, Peltoperlidae, Nemouridae, and Capnidae, where the nymphs are almost wholly concolorous, and where closely allied nymphs do not exhibit structural differences, specific identification is often very difficult or impossible.

ACKNOWLEDGMENTS

In this investigation the writer has been aided in various ways by his colleagues and students at Cornell University. The drawings of the nymphs were made by Elizabeth K. Burkmyer. Naomi Argo and Sid Robinson assisted in the rearing work of the insects, and the drawings of plates one to ten are largely the work of Mr. Robinson. Mr. Yuanting T. Chu has also assisted materially in this study. The photographs were made by the author with the assistance of Mr. Robinson. A grant from the Heckscher Research Council has made possible the pursuance of the work and assistance in the publication of the manuscript.

The frontispiece is a photograph which was colored by Ellen

Edmonson.

Nymphs have been received from the following individuals: Virgil Argo; H. S. Barber; C. Betten; S. C. Bishop; P. J. Chap-

man; R. A. Cooley; C. R. Crosby; Y. T. Chu; G. S. Dodds; T. H. Frison; J. G. Greeley; W. A. Howard; O. A. Johannsen; P. Kennedy; Elsie B. Klots; M. D. Leonard; R. Muttkowsky; J. G. Needham; P. R. Needham; Sid Robinson; Theressa R. Seeman; C. K. Sibley; R. J. Weith; C. F. Wu.

DISTRIBUTION AND HABITAT

So far as is known, stoneflies are world wide in their distribution, and may be found wherever suitable water for their development occurs. Of the two hundred eleven known North American species, the greater number are found in the Eastern States, the Rocky Mountain area, and in the far Western States, wherever cold, fresh-water streams exist. However, stoneflies also occur in places where the streams are usually sluggish and where the water becomes quite warm. Thus there have been recorded fourteen species from Kansas and twenty-four species from Illinois.

The nymphs of Plecoptera may be collected at any time of the year. Some species normally inhabit the very small, cold, upland spring brooks, while others are to be found only in the big swiftwater streams, especially in those with stony beds. There may be decided differences in the physical character of streams which the various species require, but, foremost of all, they must have

reasonably pure and well-aerated waters.

Most of the stoneflies are very sensitive to polluting substances, and the absence of nymphs in permanent fresh-water streams often is an indication of some type of pollution. Any substance which possesses toxic properties, or any organic material which in its oxidation process reduces the oxygen content of the water, may kill the entire stonefly fauna before the water becomes unbearable to much of the other aquatic life. Whereas it is not safe to assume that fresh water streams in which stoneflies are absent are necessarily polluted, it is always safe to assume that, wherever they are present, the waters are relatively clean.

The greater majority of nymphs are found in running water; some species inhabit lakes and ponds also, but only when the ponds are part of a stream which continually brings in a fresh water supply, and usually only near the lake shores where the

water is kept in motion.

FOOD HABITS

In the earlier literature on Plecoptera we usually find that stonefly nymphs "are carnivorous," and that the adults "do not take food." Even in some of the more recent textbooks on entomology the food habits of the nymphs are described as "carnivorous." (Imms, Handlirsch, et. al.) This misconception has undoubtedly been due primarily to the fact that the large and more strikingly colored nymphs of the genus Perla and Acroneuria are voracious carnivores, and these are the nymphs which are most frequently observed and collected. The European workers (Lestage, Samal, Schoenemund, Mertens, et. al) have reported from time to time that certain of the Plecoptera nymphs are herbivorous and feed on algae and other plant products. In America, Newcomer (32) was the first to report that some of the adults of Taeniopteryx feed upon leaves and buds, and at times become injurious to young fruits. Wu (57) in his paper on Nemoura reports the nymphs to be feeding on vegetation, particularly on decaying leaves. Frison (6) found that all of the nymphs of Leuctra, Taeniopteryx, and Allocapnia, which he studied, were herbivorous. He found also the adults of Taenioptervx and Allocapnia feeding on Protococcus and was able to keep them alive for extended periods of time only when he supplied them with Protococcus and water. Some twelve years ago Dr. C. H. Kennedy studied the stomach contents of Pteronarcys nymphs in Ithaca, New York, and found only plant material present in the digestive tract.

A more detailed study of the entire order indicates that, of the five North American families herein recognized, the nymphs of four (Pteronarcidae, Peltoperlidae, Nemouridae, and Capniidae) are herbivorous, and that in only one family (Perlidae) are the nymphs essentially carnivorous. In the herbivorous type (Pteronarcidae, Peltoperlidae, Nemouridae, and Capniidae) the mouth parts are adapted for manipulating plant material. The labrum is longer and narrower than in the carnivorous type; it possesses no distinct epipharynx, and the clypeal suture is distinct. The mandibles are wide and massive, and are provided with four to six short, mostly blunt, teeth, and following these teeth there is a well-developed molar for grinding the plant material. The maxillae, likewise, are fairly massive, the lacinia is wide, and more or less scooped on the inside, and bears at the apex two or three short blunt teeth. It is well fitted for wafting plant material into the mouth. The galea is strongly developed, and is usually as long, or nearly as long, as the lacinia. The maxillary palpus is much stouter than in the carnivorous type. The essential characteristics of the labium are the almost-equal development of the glossae and the paraglossae, and the stout and shortened labial

palpi.

In the carnivorous type (Perlidae) the mouth parts are built very differently. The labrum is very wide and short and is provided with a fleshy epipharynx which may protrude beyond the anterior margin of the labrum, or may be retracted underneath. The clypeal suture is obsolete. The mandibles are quite slender, the teeth are long and sharp, and the molar is lacking. The maxillae are slender. The lacinia terminates in either one or two long, sharp incurved teeth, fitted for holding prey. The galea is much reduced in size and apparently is almost without function. The maxillary palpus is long and slender. The labium is large; the glossae are reduced to small triangularly rounded lobes, while the paraglossae are enlarged into big lobes. The labial palpi are long and slender.

In addition to the differences in the structure of the mouthparts, the herbivorous nymphs are generally more cylindrical in shape, more or less concolorous, and are found more often in small, upland, spring brooks, and in quieter waters where vegetable material accumulates. The carnivorous nymphs, on the other hand, are usually more flattened, more strikingly colored, and in-

habit chiefly the larger and swifter waters.

A careful study of the musculature of the mouth parts in the two types shows many differences, and the structures of the digestive tract in the herbivores are different from those of the carnivores. Examination of stomach contents often reveals plant material, such as diatoms, etc., in the carnivorous nymphs, but such material is probably ingested incidentally to capturing animal prey, although in the early stages the nymphs apparently feed partly on algae. Similarly, one may find at times small animals, such as protozoans and crustaceans, in the digestive tracts of the herbivores.

RESPIRATION

Respiration is of the closed or apneustic type. The nymphs either absorb oxygen directly through the integument, or through tracheal gills. Many species lack gills altogether; some forms, like Perlodes, Peltoperla and a few others possess only a few single gill filaments, while others, such as Pteronarcys, Acroneuria, and Perlinella, are provided with many copious gill tufts. Wu (57) found what he considered retractile anal blood gills in Nemoura vallicularia. In this species he found also that "part of the respiratory function is performed by tufts of tracheoles that arise from the tracheal branches of the body and extend outward to lie immediately entad of the thin ventral body wall. These tufts are

present in the submentum, the coxae, the ventral side of the femora, and the first eight abdominal sternites. In the abdomen several tufts arise from each ventral abdominal commissure and extend to the posterior margin of the segment." (Plate 29, fig. 211.) In the following genera tracheal gills are absent: Isogenus. Clioperla, Paraperla, Kathroperla, Isoperla, Alloperla, Chloroperla, Perlomyia,² Leuctra, Capnia, Allocapnia, Capnura,² and certain species of Taeniopteryx, Nemoura and Perla, Perlodes possesses two or more small, fleshy, finger-like gills. In P. americana, which possesses only one pair, they are attached to the outer base of the submentum. P. tibialis has, in addition to the gills on the submentum, two pairs on the pleural conjunctivae of the thorax and P. signata has three pairs of thoracic gills in addition to the pair on the submentum. In Peltoperla arcuata five pairs of single, long, pointed, gill filaments may be seen to protrude from under the large sternal plates of the thorax where they are attached to the soft integument at the base of the legs.3

Of the genus Taeniopteryx; T. nivalis, T. maura, and T. parvula each possesses three pairs of coxal gills. These gills are threesegmented and occur as single filaments attached, one to the coxa of each leg. In certain of the species of Nemoura (N. venosa, N. sinuata, etc.) we find tracheal gills in the cervical region. These gills have been called prosternal tracheal gills by Wu (57) and he describes them as follows for N. venosa and N. sinuata: "Each gill consists of two tufts of hair-like gill filaments, the number of which varies with the species. In N. venosa, each tuft is composed of five to six filaments. In N. sinuata, there are five to six gill filaments in each outer tuft, and about fifteen in each inner tuft. A gill trachea extends downward to the base of each gill from the longitudinal trunk near the anterior margin of the prothorax. This gill trachea divides into many branches, each of which enters one of the gill filaments and subdivides into a large number of tracheoles. Loops are formed by these tracheoles in the gill-filament at its distal end."

The nymphs of the following genera possess copious gill tufts underneath the prothorax, and in some of the species gill tufts are found also on some of the abdominal segments, while in others

³ Uéno (56) reports a species, from Japan, of Peltoperla which possesses

no gills whatsoever.

² The nymphs of Kathroperla, Perlomyia, and Capnura are not known, but when they are discovered they will doubtless be without gills.

^{&#}x27;Imms (11) says, "in Nemoura, for example, they [gills] assume the form of lamellate outgrowths on the pronotum." In all the nymphs of Nemoura which I have seen these gill filaments are cylindrical.

anal gills may likewise be present. Pteronarcys possesses gills on the underside of the thorax and on the first two abdominal segments. Pteronarcella has gills on the first three adbominal segments in addition to the thoracic gills. Acroneuria and the larger species of Perla possess copious thoracic gill tufts, and some of the species are also provided with one pair of anal gills. Perlesta, Neoperla and Perlinella have both thoracic and anal gill tufts. Atoperla has long gill tufts under the thorax but no anal gills. It is impossible to say what correlation exists between habitat and presence or absence of gills, or type of gills, until we have more detailed information about the habitat and behavior of the various species.

LIFE CYCLE AND METAMORPHOSIS

It is only within recent years that attempts have been made to observe the complete life cycle of stoneflies. The time required to complete the postembryonic development varies in different

Nemoura vallicularia Wu

Instars	Dates of molting		Actual widths of head*	Computed width of head
1	July	2	2.25	2.3
2	July	$\bar{6}$	2.50	$\frac{2.5}{2.5}$
3	July	11	2.66	$\frac{2.5}{2.7}$
4	July	18	$\frac{2.75}{2.75}$	2.9
5	July	$\overline{23}$	3.00	3.1
1 2 3 4 5 6 7 8 9	August	1	3.25	3.3
7	August	8	3.50	3.6
8	August	13	4.00	3.9
9	August	22	4.25	4.2
10	September	4	4.50	4.5
11	September	12	4.75	4.8
12	September	24	5.00	5.1
13	October	2	5.50	5.4
14	October	14	5.75	5.7
15	October	23	6.00	6.0
16	November	11	6.50	6.4
17	November	30	6.75	6.8
18	December	21	7.00	7.2
19	January	10	7.50	$7.\overline{6}$
20	January	30	8.00	8.0
21	February	29	8.50	8.5
22	March	11	9.25	9.4
Transformation	March	29	10.00	9.9_{-}

^{* &}quot;Each division on the micrometer was 160 micra and was taken as a unit of measurement. The ratio of increase in the width of the head between two molts, was found to be 0.95, from which a series of computed widths of head in the instars was made to compare with the actual widths taken from the specimens."

species. In some of the smaller forms, such as the Nemouridae and Capniidae, the life cycle is completed in one year while in the larger forms, such as Pteronarcys, Acroneuria, and certain species of Perla, two to three years are required for each generation. Samal (43) estimates that *Perla abdominalis* requires three and one-half to four years to complete its development.

The number of nymphal instars may vary considerably but in the forms studied it is twenty-two or more. Tillyard (54) says, "The number of instars is not known for certain, but appears

to be usually six."

Wu (57), in studying the life history of Nemoura vallicularia, recorded twenty-two instars "from the hatching of the naiads on July 2, 1921, to the emergence of the adults on March 29, 1922."

The table on page 7 is taken from Wu.

Samal (43) found that *Perla abdominalis* also passes through twenty-two nymphal instars, which, according to his estimates, extended over a period of three and one-half to four years. His data are given in tabular form as follows:

Samal's Table of Larval Stages of Perla abdominalis

Stage Number of segments in cerci Number of segments in antennae Length of body without cerci Length of body with cerci 1 3 9 — 0.8-1 mm 2 3 9 — 1 - 1.5 3 4 11 — 2 - 3 4 5 12 — 2.5-2 2 5 6 14 — 2.5-2 2 3 3.8-42 4 <th></th> <th></th> <th></th> <th></th> <th></th>					
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Stage	segments	segments	body without	body with
23 30-34 30 00 00 00 00 00 00 00 00 00 00 00 00	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	3 4 5 6 7 9 10 11 13 17 19 20 26–28 32 35 35–40 36–40 44–45 740–43 49–50	9 11 12 14 17 16 (?) 17 19–20 23–24 28 31 33–37 36–39 33–41 44–47 48–52 58 60–65 60–67(70) 79–85		$\begin{array}{cccccccccccccccccccccccccccccccccccc$

Schoenemund (44) reports that the female nymph of *Perla cephalotes* sheds its skin thirty-three times before reaching maturity; eighteen times during the first year, nine during the second, and six times during the third year. The male nymph, he says, being much smaller, passes through fewer instars than the female. However, according to Samal (43) both male and female nymphs of *P. abdominalis* have an equal number of molts. The nymphs are less active in cold weather than when it is warm, but they feed more or less during the entire winter. Molting is less frequent during cold weather, and the nymphs cease feeding during the process of ecdysis. There is a period of several days before the mature nymphs emerge when they take no food whatsoever, and such nymphs will usually be found to have an empty digestive tube.

COLLECTING, TRANSPORTING, AND REARING STONEFLIES

Collecting stonefly nymphs is rather a simple matter. Where only a few specimens are sought, or where only a superficial qualitative survey is to be made, nymphs can usually be procured by hand picking. The large nymphs of Perla, Acroneuria, and others will be found chiefly in the large swift-water streams where they occur underneath the stones. Upon quickly lifting such stones out of the water, the nymphs often remain attached to the underside, and can then readily be taken.

In the smaller streams or in the upland brooks which are inhabited by Pteronarcys, Peltoperla, Nemoura, Leuctra, and others, the nymphs are found among the leaf drifts and in the debris. A handful or two of such debris will usually yield several specimens. Since the nymphs which occur in these smaller streams are mostly concolorous, they so nearly harmonize with the color of the dead leaves and sticks that they are not easily recognized. It is well, therefore, to spread out the debris on a flat surface or in a pan, and carefully search out the nymphs, especially the smaller ones, which often can be detected only after they start moving around. The most efficient manner in which to obtain the smaller forms is to bring a good supply of trash to the laboratory where it can be spread out in a large shallow pan in a little water. The nymphs soon start to crawl about and are then easily picked out.

Where a large number of specimens is to be collected, or when a thorough qualitative collection is to be made, it becomes desir-

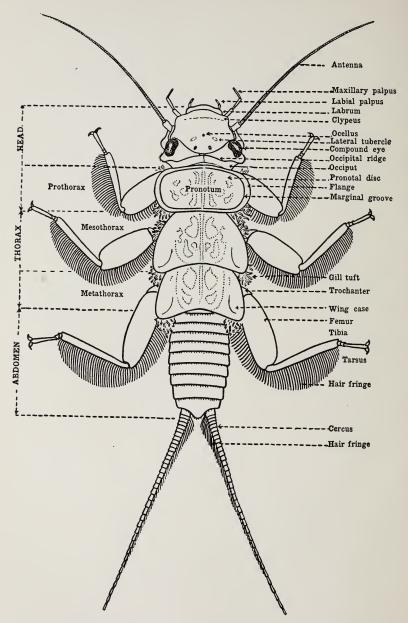


Fig. 1. A generalized stonefly nymph showing the main structural parts used in the descriptions and keys of the various species.

able to employ a few collecting implements. In the larger swiftwater streams, a piece of wire screen may be placed in the water in such a way that the current sweeps the specimens against the screen as they are dislodged from their hiding places under the stones, when the stones are stirred up by means of a stick, hoe, or rake. By nailing a piece of wire screen on two short handles, the net can more readily be held in place in the stream (text figure 2).

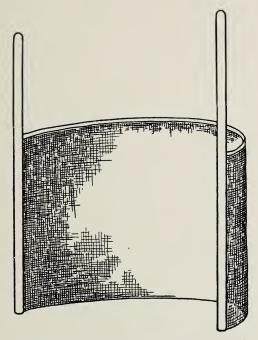


Fig. 2. Wire screen used for collecting stonefly nymphs in rapid streams.

For all-round collecting of stonefly nymphs, the sieve net is most desirable (text figure 3). This net may be placed in the stream and used as a screen for collecting the nymphs as they are carried down by the current, while the collector holds the sieve net by the handle, and, by means of a stick, or with his feet, dislodges the specimens from underneath the stones above stream. The net is also very useful for dragging material out of the stream as one stands on the bank, and after specimens have been collected, it serves, likewise, as a washing sieve, and much of the detritus

can be washed out by swishing the net back and forth in the water. If made of strong material this net will stand considerable abuse.

Transporting Live Nymphs. Since most of the stonefly nymphs live in moving and well-aerated water, they cannot be transported

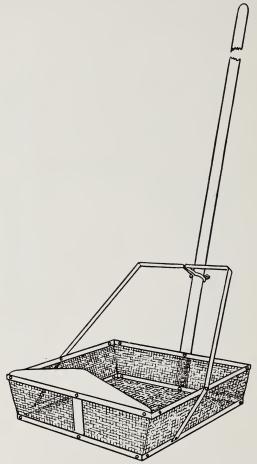
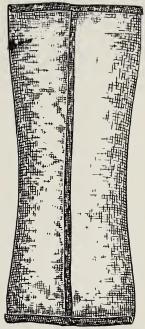


Fig. 3. Sieve net for collecting stonefly nymphs.

nor kept for any length of time in water-filled containers unless the water is continuously aerated. A minnow pail with a compressed-air chamber, from which a small stream of air bubbles passes through the water, has been found very useful in carrying nymphs from the field to the laboratory. A very satisfactory method of transporting nymphs is to wrap them in a clean piece of wet cheese cloth. This keeps the specimens moist and well supplied with air. Wrapped up in this manner, specimens of Perla and

Acroneuria, which are extremely sensitive to suffocation, have been kept alive for a week or more. Nymphs packed in sphagnum may likewise be kept alive over a considerable period of time. In the laboratory where the nymphs are to be kept under observation for some time, they should be placed either in an aerated container or else in a pan which contains barely enough water to cover the specimens. In such pans the nymphs may often be seen to move their bodies up and down in a rhythmic manner, apparently for the purpose of better aeration.

Rearing. In rearing nymphs, it is desirable to keep them under conditions closely resembling or paralleling their natural habitat. Where a small cold spring brook is conveniently located, and insured against disturbance from man and animals, the nymphs can be kept satisfactorily. The most satisfactory breeding eage is one made of wire in rearing stonefly nymphs. screen (text figure 4). These screens can



be made in various sizes, are easily transported, and are very adaptable for varying conditions. For rearing the larger species, 14 or 16 mesh screen is entirely satisfactory, but for the smaller species of Nemoura, Leuctra, Capnia, etc., screen with a finer mesh is necessary. After the nymphs have been put into the cages, they are placed in the water, leaving the upper half of the cage exposed to the air so as to allow for emergence of the adults. Food must be supplied to the nymphs. For the herbivores, such as the Pteronarcidae, Peltoperlidae, Nemouridae, and Capniidae, decaying leaves, algae, and detritus may be used, and for nymphs of the Perlidae, living insects, such as Mayflies and Chironomids, should be added. Inasmuch as the nymphal stage extends over a long period of time, it is desirable to choose the maturer nymphs for rearing. By observing the conditions of the wing pads, one soon learns to pick out the nymphs which are approaching emergence. At the time of transformation the nymph crawls up on the screen out of the water and after the adult has emerged the nymphal skin remains attached to the screen. The adult and nymphal skins may then be placed together in a vial of alcohol and preserved for study. Where an outdoor natural stream is not available for rearing purposes, the nymphs, if quite mature, can sometimes be reared by keeping them in moist sphagnum. Frison (6) reared a number of nymphs in small tins containing moist leaves. Aquaria, in which the water does not get too warm, and through which a constant stream of air is kept flowing, may also be utilized for rearing. Tap water is, in most cases, toxic to the nymphs, and therefore cannot be used.

PRESERVATION FOR STUDY

The most satisfactory manner of preserving nymphs for study is to place them in 80 to 85% alcohol. Pinning or preserving the nymphs or nymphal skins dry is not satisfactory since the gills and the other delicate structures shrivel up so badly that identification becomes difficult or impossible. Alcohol tends to fade out the colors to some extent but usually not sufficiently to make determination impossible. Nymphs which are to be examined for food contents should be placed in alcohol or in a 4% formalin solution immediately after being taken from the water. Identification of the intestinal contents will be easier if examination is made as soon as possible after the specimens have been brought to the laboratory. If this is not feasible, the nymphs should be slit before they are placed in the preservative to insure better preservation of the food contents of the intestine.

TECHNIQUE

The technique involved in the study of stonefly nymphs is quite simple. In most instances it is possible to recognize the genera, as well as many of the species, by examining the entire specimen under the binocular microscope, while the larger species can often be identified with a simple lens, or even with the unaided eye. In some specimens, identification to genus can readily be made by a study of the details of tracheation or of venation. In such cases it is usually better to cut off the wing pads and mount them on slides. The wing pads may be readily snipped off with a sharp scalpel, a razor blade, or with a pair of fine-

pointed scissors. In the nymphs of Acroneuria, Peltoperla, etc., care should be taken to cut off enough of the inner portion of the wing pad to prevent unnecessary disturbance of the delicate veins or tracheae. If the mount is to be temporary only, the wing pads may be examined in a drop of alcohol or of water under the microscope, or a somewhat more permanent mount may be made in a glycerine jelly. For permanent mounts, however, it is best to stain the wing pads in a rather weak solution of alcohol eosin, leaving them in the stain for half an hour or more, and thereafter clearing the wing pads and transferring them to balsam. Such staining brings out the venation more plainly and places the preparation on permanent record. Figures 165 to 168 show how clearly the venation may be observed in permanently mounted wing pads.

The mouth parts are readily dissected out in the larger specimens, but in the smaller, more delicate species, care must be exercised to prevent tearing the appendages and the sclerites. In some cases it is advisable to carry the entire head through the dehydrating, clearing, and staining process, and to separate the mouth parts after the head has been transferred to the balsam. In the larger forms it will often be found advisable to soak the mouth parts in caustic potash for a short period. This softens and clears them and aids in getting rid of much of the muscle tissue. Appendages, such as legs, cerci, and antennae, may be mounted in a similar manner. In many instances, identification of the nymphs is possible by a careful study of the developing genital structures. Mature nymphs will often show these structures remarkably well. In some nymphs it becomes necessary, however, to "peel off" the nymphal skin before the genitalia can be distinctly seen. This process is somewhat tedious, and is best accomplished by the use of a pair of fine and very sharply pointed needles. Specimens which have been in alcohol for a considerable period of time usually respond to such treatment more readily than the fresh ones. After the nymphal skin has been removed, it is often possible to make positive identification, even though the genitalia may appear much distorted or flattened.

ILLUSTRATIONS

The drawings of the mouth parts, wing pads, and legs were made by means of a projecting drawing apparatus after the parts had been mounted on slides. The drawings of the nymphs were made on Ross stippling paper. The photographing of nymphs requires time and patience, and best results can be obtained only with freshly collected specimens. After the nymphs had been killed in weak alcohol they were placed in a tray containing a wax bottom to which the specimens could be fastened by means of small pins. Minutien Nadeln served very well for holding the appendages in place after the nymph had been properly spread. The nymphs were then dehydrated in alcohol, and after they had been in 95% alcohol for several hours the entire specimens had hardened so that the pins could be removed without any further danger of distortion or of movement of appendages out of place. Each nymph was then placed in a clean petri dish, a piece of glass was laid on the nymph to hold it in place, and sufficient alcohol was poured into the dish to cover the specimen. To obtain a white background, the petri dish, containing the specimen, was placed on a glass plate underneath which a sheet of white paper was inserted about a quarter of an inch below the surface of the glass. For a black background, a piece of black velvet was fastened to the bottom of a tray. Fine pins were then used to hold the specimens up about a quarter of an inch above the velvet. After pouring enough alcohol into the tray to cover the specimen it was photographed. Artificial light was used in making all the photographs included in this paper.

EXPLANATION OF TERMINOLOGY

To facilitate the interpretation of the structures or characters which are referred to in the text and in the descriptions of the species, the following explanations are given (see also text figure 1).

Length of body. This refers to mature nymphs, unless otherwise indicated, and includes the length as measured from the front of the head to the tip of the abdomen, exclusive of antennæ and cerci.

The terms *long* and *short* are unfortunate ones to use but in many instances it is almost impossible to express relative sizes and measurements in any other way; so these relative terms cannot convey full meaning until after one has become somewhat acquainted with the group.

Form of body. The bodies of all the nymphs are somewhat flattened but the term "flattened," as used here, refers to such forms as Acroneuria in which the body is very much depressed, while "cylindric," or "cylindrical," denotes such forms as Pteronarcys, in which the body is only slightly depressed.

Color. "Brown" must be interpreted as ranging from light brown to dark brown or even to almost black as the depth of color varies considerably in a series of nymphs of the same species. "Yellow" varies from white or straw color to deep yellow, in

some forms verging on brown or reddish.

Color pattern. There is some variation in the color pattern of nymphs of the same species, and this must be kept in mind when interpreting the descriptions and illustrations. In the darker-colored nymphs of Perla media, for example, the entire nymph appears almost uniformly brown, especially where the vestiture of the body has collected silt which adheres to the hairs, while in the lighter forms the thorax, in particular exhibits a distinct color pattern of yellow and brown markings. In utilizing the color patterns in the keys, an attempt has been made to refer only to those patterns which show the least amount of variation.

Vestiture. The degree of hairiness varies in the nymphs of different species, but also varies in individuals of the same species. The younger nymphs of Perla immarginata apparently have more and longer hair on the body than have the mature forms. Variation in the amount of hairs is also due to the fact that in some

specimens the hair seems to have worn off.

Head. The width of the head in relation to the width of the pronotum refers to the maximum width of the head across the eyes, as compared to width of the pronotal disc. The epicranial suture, while apparently not of particular significance as a diagnostic character, serves as a convenient landmark for reference to structures or patterns. The ocelli vary in size and position and may be either two or three in number, or in some instances they appear to be wholly absent. Wherever only two ocelli are present, the anterior one is lacking. On either side of the ocellar triangle may be seen a rounded or oblong, slightly raised spot—these spots are known as lateral tubercles. The occiput is that portion of the head posterior to the ocellar triangle. In some species there is a distinct occipital ridge extending transversely across the occiput from one eye to the other. This ridge may be very distinct, as in the larger species of Perla, or only indicated by a more or less continuous line of short hairs. The clypeal-labral suture is obsolete in some forms and distinct in others. The labrum is always wider than long, and in the Perlidae is provided with a distinct epipharynx, which however may be so completely rolled under the labrum as to be hidden from view.

Antennae. These are long and slender and composed of many (30-100) short segments,

Mouthparts. These offer excellent characters for taxonomic use, but inasmuch as they are described under each genus and are

figured they need not be further discussed here.

Pronotum. The relative width of the pronotum to its length refers to the chitinized pronotal disc. The marginal groove is the groove which in some nymphs can be traced around the entire pronotum while in others it can be definitely seen only along the middle of the anterior and posterior margins.

The lateral flange is that portion of the pronotal disc, lateral to the marginal groove, especially where the sides of the pronotal disc flare out over the general prothorax, as in Acroneuria ruralis Hag. The markings on each side of the pronotum are sometimes referred to as rugosities or embossings. The median line is the middle longitudinal line along which the pronotum splits when

the image emerges.

Meso- and Metathorax. The wing pads (wing cases) vary in shape, size, and in their relative position to the rest of the body. In immature nymphs they are naturally smaller and less conspicuous than in the more mature forms. In such forms as Aeroneuria, the wing pads form a definite part of the meso- and metanotum and do not project in the form of long appendages; while in other genera, Nemoura, Leuctra, etc., the wing pads develop into long appendages, extending far beyond the general posterior margins of the meso- and metanotum. In Taeniopteryx and Nemoura, the wing pads, especially the hind ones, are directed away from the body at a wide angle, while in Leuctra etc., they lie parallel to the body.

Abdomen. The abdomen is composed of ten segments. In some genera the sexes can readily be distinguished in the nymphs, while in others the sexes are not so apparent. Where the developing genitalia are large and conspicuous, identification can be made with a greater degree of certainty than where the genitalia cannot be observed. The cerci are composed of many segments, and an attempt has been made to record their number; however, the basal segments are usually so short and often so indistinctly indicated, that the recorded number can only be regarded as ap-

proximate.

Gills. These serve as excellent characters in separating some of the genera, and also are useful in the grouping of species within a genus. The very small finger-like outgrowths at the base of the labium, and on the conjunctivae of the thorax in Perlodes are in this paper referred to also as gills. Whether they actually possess any respiratory functions is not certain.

Legs. The hairs on the outer margin of the legs are referred to as the outer or marginal fringe. There is considerable difference in the length and density of the hairs in these fringes.

The relative length of the tarsal segments, unless otherwise stated, is to be considered as meaning the length as viewed from the side, and not as seen from above.

CLASSIFICATION

SUMMARY OF CHARACTERS

THE nymphs of Plecoptera are aquatic, living mostly in running water. They are said to resemble the adults, but in some genera, such as Peltoperla for example, the resemblance of nymph to adult is quite remote. The mature nymphs range in size from the small Capniidae and Nemouridae, in which some species do not measure over six or seven millimeters in length, to the large nymphs of Pteronarcys which attain a length of two inches or more.

The general color of the nymphs is yellowish brown, to dark brown or blackish; or patterned with yellow and brown, or yellow and black.

Four of the five North American families (Pteronarcidae, Peltoperlidae, Nemouridae, and Capniidae) may be said to be quite uniformly brown in color and in only one family (Perlidae) are found the brightly colored or more strikingly patterned nymphs.

The general form of the body is elongate, subcylindrical, or considerably depressed, the nymphs of the Perlidae being, in general, more flattened than the nymphs of the other families. The body regions are well defined; the pro-, meso-, and metathorax each are large and distinct, and the entire thorax is about as long as the abdomen.

The head is more or less triangular in shape and is about as wide as, or a little wider than, the pronotum, except in the Peltoperlidae and the Pteronarcidae where the head is much narrower than the pronotum. The compound eyes are well developed and there are usually either two or three ocelli present. The V-shaped epicranial suture is not apparent in the Perlidae, but is distinct in all other families. The antennae are filiform, composed of many segments, and normally half, or nearly half, as long as the body.

The mouth parts are of the chewing type and are strongly developed. In general structure they resemble the Orthopteroid mouth parts. The labrum is wider than long and fringed with hairs on the anterior margin. In the Perlidae, the labrum bears on the median anterior area a fleshy epipharynx which is closely beset with very fine bristles and may be rolled out or retracted.

The mandibles are asymmetrical, more or less triangular in

shape, and provided with about four to six teeth. There are two distinct types of mandibles: (1) those of the family, Perlidae, in which the teeth are long and sharp and without a molar, (2) those of all other families in which the teeth are usually shorter and less pointed, and a well-developed molar is present. On the portion immediately following the teeth, the mandibles bear a fringe of long stiff hairs.

The maxillae are of two distinct types. In the Perlidae the lacinia terminates in one or two long, slender, incurved teeth while in the other families the lacinia is rather wide at the tip with two or three very short, blunt teeth. The galea is weak in all Perlidae and large and strongly developed in all other families. The five-segmented palpus is long and slender in the Perlidae, and shorter and more robust in the other families.

The labium varies considerably in size and shape, but here again may be found two types. In the Perlidae, the glossae are short and triangular, while the paraglossae are large and extend far beyond the tips of the glossae. In all other families the glossae and paraglossae are subequal and almost equally long. The three-segmented labial palpus is long and slender in the Perlidae, and robust and short in all others. The mentum is reduced to a narrow transverse band, while the submentum is very large.

The hypopharynx is well developed, and bears at the apex a large number of short stiff bristles.

The pronotum is much wider than long, and in most nymphs the lateral discs are embossed with various-shaped markings. The marginal groove is more distinct in the Perlidae than in the other families.

The meso- and metanotum are large, and bear the developing wing pads. In some of the nymphs the wing pads are small, and consist of the slightly produced postero-lateral angles of the meso-and the metanotum, while in others, the wing pads develop into long sac-like appendages.

The legs are rather long and may be very much depressed or only slightly flattened. Usually the outer margin bears a fringe of long hairs. This fringe is especially long and thick in those forms which inhabit swift water. The tarsus is composed of three segments of which the first two are shorter than the third. There are two tarsal claws but no pulvillus. The abdomen may be either flattened or subcylindrical. There are ten abdominal segments, one supra-anal lobe, and two subanal lobes. The supra-anal lobe is fused with the tenth abdominal tergite and is not always distinct.

The cerci are long and slender, and in most nymphs they are half

or more than half as long as the body.5

Gills may be absent or present. Whenever they are present they are found on the ventral or pleural regions. The gills may occur in tufts underneath the thorax, on the first few abdominal segments, attached to the subanal lobes, or they may occur as single filaments in the cervical region, attached to the coxae or to the submentum.

It is not always easy to distinguish the sexes, especially in immature nymphs, but in some genera the sexes may be recognized very readily, and in all mature nymphs the sexes may be separated by studying the developing genital characters. Perhaps one sure way of recognizing female nymphs is to examine the posterior margin of the eighth abdominal sternite. Even if no other character is discernible, the marginal fringe of fine spinules will be absent in the spot where the genital opening develops.

Key to the Families and Genera of the Nymphs of Plecoptera

1. Gills on first two or three abdominal segments as well as under the thorax; pronotum wider than head; ligula 4-lobed, i.e. glossae about as long as paraglossae; mostly large dark brown nymphs; herbivores.....Pteronarcidae 2 (p. 26)

No gills on first two or three abdominal segments......3

2. Gills on first and second abdominal segments only; large nymphs, 1½ inches or more in length when fully grown; corners of pronotum usually produced. Pteronarcys (p. 27)

3. Brown, roach-like in form, head bent under; terga and pleura of thorax developed into very large wide shields from under which usually small white gill filaments protrude; herbivores

One genus Peltoperla (p. 38)

Body elongate, head directed forward, pro, meso, and metanotum not unusually developed.....4

⁵ Imms (11) page 246, in speaking of stonefly nymphs says: "in some cases (e.g., Nemouridae) however, the latter appendages (cerci) are in the form of minute single-segmented structures." This misconception has undoubtedly resulted from the fact that, in the adults of Nemoura, Leuctra, etc., cerci are composed of a single small segment. So far as known all stonefly nymphs have long, many-segmented cerci.

4.	First and second tarsal segments very short, subequal, together less than half as long as third; labrum three to four times as wide as long; labial palpi slender and reaching far beyond the tip of labium, which is 2-lobed (i.e., glossae are much reduced); mandibles slender and without a molar; body mostly flattened; carnivores; all strikingly colored nymphs belong here
	under 1 inch in length when fully grown; herbivores 16.
5	Only two distinct ocelli present; copious gill tufts under
υ.	thorax6
	Three ocelli; with or without gills
6.	Two ocelli set very close together; caudal gills present; occipi-
	tal ridge present; lacinia of maxilla bidentate
	Two ocelli separated by several diameters of a single ocellus;
	caudal gills and occipital ridge absent; lacinia unidentate
7.	With branched filamentous gill tufts on the under side of the
	thorax at the base of the legs
	Without branched gill tufts; in some nymphs there are, how-
Q	ever, small, single, inconspicuous gill protuberances 11 Head very long; eyes small and set far forward so that the
0,	distance from the posterior border of the eye to the hind
	margin of the head is much greater than the diameter of
	the eye; gills much branched and about as long as the
	front femora; small caudal gillsPerlinella (p. 79)
	Head shorter; distance behind the eyes less or at most not
	much greater than the diameter of the eye; gills usually
0	much shorter than the front femora
9.	Mature nymphs not over half an inch in length; body usually freekled with small brown dots; cerci almost as long
	as body and composed of about 25 long segments; second
	tooth of lacinia very large and not followed by a fringe of
	hairs
	Mature nymphs usually much more than half an inch in
	length; body concolorous or with yellow and brown pat-
	tern, but not freckled; cerci usually of more than 30 seg-

	ments; licinia with a fringe of hairs below the second
	tooth
10.	A distinct occipital ridge extending transversely across the
	head from the posterior margin of one eye to the other
	No occipital ridge present; mostly strikingly patterned
	nymphs
11.	Very small, inconspicuous, single, finger-like gills at the outer
	base of the submentum, and sometimes also on the lateral
	margins of the thorax between the bases of the legs
	Perlodes (p. 41)
	No gills on submentum
12.	Head very long, squarish; eyes small and set far forward so
	that the distance from the hind margin of the eye to the
	posterior border of the head is much greater than the
	diameter of the eye
	Head not strikingly long; distance from the hind border of
	the eye to the posterior margin of the head not much more
	than the diameter of the eye
13	Very wide through the wing pads and with the lateral mar-
10.	gins of the pads broadly rounded; lacinia unidentate;
	maxillary palpus with the first four segments about equally
	large in diameter, but with the apical segment strikingly
	slender and the tip of the fourth segment somewhat pro-
	duced beyond the base of the apical segment ²
	Not exceptionally wide through the wing pads; lateral mar-
	gins of wing pads straight or sinuate but never broadly
	gills of wing pads straight of sinuate but hever broads,
	rounded; lacinia bidentate, or, if unidentate then the galea
	is much reduced and less than half as long as the lacinia;
	apical segment of maxillary palpus not strikingly thinner
	than the previous ones, although the segments are succes-
	sively reduced in size 14

² Chloroperla which has only one species, cydippe, can not easily be separated from Alloperla but in Chloroperla the anterio-lateral angles of the submentum are not produced beyond the mentum while in the Alloperla, which are known, they are produced to, or nearly to, the base of the labial

palpi.

¹ Acroneuria ruralis and A. depressa will also key out here since they each possess a distinct occipital ridge. However, A. ruralis will be recognized by its nearly uniform light brown color, the wide pronotum with wide flanges, and the long cerci which are longer than the body. A. depressa is a Western species, possesses anal gills and therefore could be confused only with P. capitata from which it differs greatly in color pattern, as shown in the illustrations of these two species.

	Maxillae very large and projecting out laterally from the head so as to be plainly visible from above; i.e. the elbows of the cardo and stipes stand out so as to increase the apparent diameter of the head. Gill-less Perla and Isogenus
	without longitudinal stripes on the abdomen
16.	Apical segments of palpi not very slender and not drawn to a sharp point; lacinia gradually narrowing to the base of the teeth; mostly contrastingly colored nymphs with longitudinal stripes on the abdomen Isoperla (p. 71) Hind wing pads diverging considerably outward from the body (except in Leuctra where the wing cases are long and narrow, the hind ones about as narrow as the front ones and lying parallel with the body, and the labial palpi extending far beyond the tip of the ligula); gills, when present, either at the throat or as single filaments at the base of the legs
17.	Hind wing pads not much divergent from the body and wider than the front ones; gills absent; labial palpi never reaching beyond the tip of the ligulaCAPNIDAE 19 (p. 109) First and second tarsal segments subequal in length; hind wing pads very wide and diverging almost at right angles from the body, i.e. the anal margin; gills, if present, 3-segmented single filaments attached to coxae
18.	First segment of tarsus much longer than second; gills, when present, located at the throat
19.	Body slender, smooth; hind wing pads hardly wider than front ones; no gills; labial palpi extend beyond ligula

Family PTERONARCIDAE

The nymphs of this family are readily distinguished from all other stoneflies. They are the only ones that have tufts of gills on the first two or three ventral abdominal segments. Their bodies are cylindrical and their color is almost uniformly brown to blackish.

Head rather small, narrower than prothorax; three ocelli placed in an equilateral triangle; antennae long and slender with prominent antennal plates; occiput rugulose; anterior to the ocellar triangle a reddish V-shaped or M-mark. Mouth parts well developed for masticating the vegetable food on which they subsist.

Labrum narrow, about twice as wide as long.

Mandibles asymmetrical; the left mandible with five unequal teeth followed mesad by a well-developed molar beyond which there is a tuft of hairs; the right mandible usually possesses only four unequal teeth.

Maxillae: maxillary palpus stout, five-segmented; galea rather broad, and made up of two segments—a short basal, and a large apical segment—tipped with a bunch of spinules; lacinia tridentate; cardo about half as long as the stipes.

Labium much longer than wide, with glossae and paraglossae subequal; the three-segmented palpus stout; mentum a small, narrow transverse triangular band; submentum very large with a sinuated posterior margin; hypopharynx rounded, hairy, and projecting beyond the tip of the glossae.

Pronotum about twice as wide as long, the sides somewhat flaring and the angles usually more or less produced; surface somewhat rugulose. Legs stout; segments of tarsus unequal, the second about half as long as the first, and the third more than twice as long as one and two combined; margins of femur and tibia with a fringe of hairs. Wing pads well developed.

Abdomen cylindric, the abdominal segments either smooth or with lateral teeth or hooks. Cerci hardly ever more than half as long as the body. Thirteen to seventeen pairs of tufted gills, located on the ventral side of the thorax and on the first two or three abdominal segments.

General Distribution

Quite universally distributed over North America (except Pteronarcella which is a Western genus) wherever small, cold, upland spring brooks may be found.

Biological Notes

The nymphs of this family are all herbivorous and feed upon almost any kind of fresh and decaying vegetable matter. Stomach examinations often reveal large pieces of wood and other vegetable matter in the intestines of the large nymphs. The nymphs are not adapted to live in swift running water and normally inhabit the small upland spring brooks which are not subject to disturbance by floods. Here in the accumulated debris on the bottom of the little streams one will find the nymphs well protected by the concolorous brown of their bodies which simulate short pieces of dead and decaying wood. The nymphs are very clumsy and are unable to move rapidly. Upon being taken out of the water, they curl up, remain motionless for some time, and thereby easily escape detection in the debris.

Smith (53) quotes Barnston as saying that "it [Pteronarcys nymph] constantly resided in the water at the bottom of streams and rivers," and then states further, "I have always found it clinging to the under side of stones in the most rapid parts of streams." Muttkowsky (21) reports Pteronarcys nymphs from rapid water streams in Yellowstone Park. I have found them very common only in the smaller spring brooks, and only occasionally have I observed the nymphs in the swifter water. The nymphs of this family lack the stream-line form of body and their food habits would not seem to permit their remaining under stones in the rapid part of streams.

Not much is known about the life history of the species of this family. The life cycle occupies not less than two years, and, in the genus Pteronarcys, in all probability occupies three years. Emergence takes place during the summer months, and it is very easy to rear the species if fresh running water is available.

Genus PTERONARCYS Newman

This genus includes our largest stoneflies, the mature nymphs measuring up to fifty millimeters or slightly more, in length. The nymphs are of an almost uniform chocolate to blackish color, more cylindrical than any of the other large stoneflies, and are further easily recognized by their copious white gills which cover the entire ventral surface of the thorax, as well as the first two abdominal segments.

Head rather small and much narrower than the prothorax which flares somewhat over the head; antennae long, slender, tapering, and made up of fifty-five to sixty, or more, segments; the three occili forming an equilateral triangle, the hind occili

being a little closer to each other than to the eyes; on either side of the ocellar triangle a rounded reddish spot, and a reddish V-or M-shaped mark in front of the ocellar triangle; occiput with longitudinal reticulations; supra-antennal plates well developed.

Prothorax about twice as wide as long with flaring sides and with its angles more or less produced; surface of pronotum with embossed markings; meso- and metanotum with coloration similar to that of pronotum but less rugose; in some species the lateral margins of pronotum and wing pads are lighter. Legs stout, brown; femora usually with a narrow median lighter line above; outer margin of femora and tibia fringed with hairs; first two segments of tarsus short, the first about twice as long as the second, the third at least twice as long as one and two together; two tarsal claws, each with a blunt tooth at the inner base.

Abdomen cylindric, segments either smooth or with lateral teeth. In the female the tenth abdominal tergite is medially produced into a sharp triangular conical process, while in the male it is variously modified; cerci rather short, containing up

to forty or more segments.

The thirteen pairs of gills on the ventral side copious and long, and arranged as follows: prothorax with five pairs, three pairs in front of the prothoracic legs arranged as a transverse collar along the neck, and two pairs just posterior to the front pair of legs; three pairs on the mesothorax; three pairs on the metathorax and one pair on each of the first two abdominal segments.

Mandibles asymmetrical, the dentation of the left and right mandibles being different. The left mandible has the following five sharp teeth: first, second, and fourth longest, largest, and most pronounced; third and fifth teeth small, and, in some cases, fifth rather inconspicuous. These five teeth followed by a large molar, and beyond this the mandible bears a bunch of long hairs. The right mandible has four teeth, the first two of which are largest; following the fourth tooth which is the smallest, a large quadrangular molar, and this is likewise followed by a brush of hairs.

Labrum almost exactly twice as wide as long, with long hairs on the front margin, which is concave in the center; hind margin somewhat sinuate; posterior angles sharp; chitinous prolongation for muscle attachment about one-third as long as width of labrum.

Maxillae: maxillary palpus composed of five rather stout segments; segment one a trifle longer than wide, segment two about one-fifth longer than wide, segment three half again as long as wide, segment four slightly less than twice as long as wide, seg-

ment five nearly three times as long as wide. Palpi sparsely clothed with hairs. Galea rather broad and blunt, and slightly longer than the lacinia; made up of two segments, a short basal one about one-fourth the length of the entire galea, and larger distal one clothed with hairs, and at the tip a bunch of spinules. Lacinia bears three teeth at the tip, two of which are about equal in length, the third short; inner surface grooved, and the ventral carina which borders the groove bears a row of long hairs.

Labium and hypopharynx: labium almost twice as long as wide; glossae and paraglossae about equally long so that the labium is made up of four subequal lobes, the lobes hairy and bearing at their tips bunches of hairs or spinules, the glossae always bearing a bunch of hairs, and the paraglossae bearing either hairs or spinules. Mentum narrow and broadly triangular; submentum a little wider than long and widened posteriorly with the posterior margin sinuate. Labial palpi with three segments, first a little longer than wide, second half again as long as wide, third almost twice as long as wide. Entire labium more or less clothed with hairs.

Key to Nymphs of Pteronarcys

	zee, to refine or reconstruction
1.	Abdominal segments with large lateral teeth or hooks 2 Abdominal segments without lateral hooks 3
2.	Hooks on abdominal segments large and directed outward,
	those on segments seven and eight almost as large as the
	preceding ones; ceri more than half as long as abdomen;
	front angles of pronotum producedbiloba Newm. (p. 30)
	Hooks appressed to body, small on segment seven, and in-
	conspicuous on eight; cerci less than half as long as abdo-
	men; front angles not noticeably produced
3.	Lateral prothoracic teeth long, slender, sharp, and directed
	outward; supra-antennal plate prolonged into a sharp
	tooth; wing pads pointedcalifornica (Newpt. (p. 32)
	Lateral prothoracic teeth short and not directed outward so
	much; supra-antennal plate blunt; wing pads rounded 4
4.	Eastern species; prothoracic teeth usually as long as wide;
	ninth sternite of male produced beyond the tenth; tenth
	tergite of female nearly straightdorsata Say (p. 31)
	Western species; prothoracic teeth usually shorter than wide;
	ninth sternite of male narrow and not produced; tenth
	tergite of female with the apex considerably elevated
	princeps Bks. (p. 33)

Pteronarcys biloba Newm.

(Plate 2, figs. 17-21; plate 11, figs. 171-172; plate 34, fig. 232; plate 35, figs. 235-236.)

Length of body up to 40 mm.; antennae up to 16 mm.; cerci

up to 12 mm.

General color, chocolate brown to blackish, sometimes with indistinct lighter longitudinal stripes upon the abdomen; in living nymphs, orange markings on the lateral margins of the pronotum, and a yellowish orange band on the middle portion of the antennae and cerci, which fades to pale yellow in alcoholic specimens.

Head much narrower than prothorax; uniformly brown except for the somewhat lighter smooth rounded marks each side of the ocellar triangle, and usually with a lighter median area near the posterior margin of the occiput, which possesses numerous longitudinal rugosities; antennae of sixty or more segments, blackish, but with a yellow band covering four to ten segments, just beyond the middle, and lighter toward the tip.

Pronotum almost twice as broad as long, widened posteriorly, front angles considerably produced, hind angles sub-acute; front margin somewhat concave, hind margin sinuate; disc of pronotum with coarse but not very deep rugosities; dark brown

with lighter margins.

Legs brown with tips of the femora and the tarsi lighter, also a narrow lighter longitudinal line on the femora; the femur, tibia,

and tarsus fringed with hairs.

Abdomen cylindric, dark brown with lighter markings; abdominal segments one to eight with large lateral apical hooks directed outward from the body. Although these hooks become shorter posteriorly, they are very pronounced on the eighth segment; segments nine and ten of abdomen smooth; tenth tergite much produced. Cerci of about forty segments, dark brown, with a yellow band beyond the middle, and sometimes with the tip lighter.

Many nymphs from: Ithaca, N.Y.; Oneida Co., N.Y.; Tarbel, N.Y.; Allegany Co., N.Y.; Old Forge, N.Y.; Moffitsville, N.Y.; Osgood R., Adirondack Mts., N.Y.; Ammanoosie R., W. Milan,

N.H.

Pteronarcys proteus Newm.

(Plate 1, figs. 11-16; plate 11, figs. 169-170; plate 34, fig. 234; plate 35, fig. 237.)

Length of body up to 40 mm.; antennae up to 21 mm.; cerci up to 7 or 8 mm.

General color chocolate brown to dark brown, paler on the ventral surface.

Head much narrower than pronotum; brown, with rounded, smooth, yellowish discs on each side of the ocellar triangle; antennal plates prominent but not much produced; occiput with many longitudinal rugosities. Antennae brown, the middle third usually paler, composed of sixty to sixty-five segments.

Pronotum nearly twice as broad as long, slightly widened posteriorly, the angles all somewhat produced, but less than in biloba; front margin a little arcuate, hind margin convex; discs

rugose.

Legs brown, femur, tibia, and tarsus fringed with long hairs. Abdomen brown, segments one to seven with lateral apical hooks, and usually also a suggestion of a hook on segment eight. These hooks are directed backwards and lie close to the body; tenth tergite much produced. Cerci brown, usually a lighter band in the middle, and lighter at the tip; thirty to thirty-five segments.

The chief difference between proteus and biloba is the structure of the abdominal hooks, the length of cerci and the shape of the pronotum; biloba always has distinct hooks on segment eight and all hooks are directed away from the body, proteus has only a suggestion of hooks on abdominal segment eight, and even on seven the hooks are often inconspicuous, while the remainder of the hooks are always close to the body. The cerci are shorter in proteus than in biloba; the front angles of the pronotum are less produced in proteus than in biloba. The gills are very similar to those of biloba.

A juvenile specimen, 10 mm. long has only ten pairs of gills which are distributed as follows: three pairs in the cervical region, two pairs between pro- and mesothoracic legs, two pairs between meso- and metathoracic legs, one pair between the hind pair of legs, and one pair on each of the first abdominal segments.

From Ithaca, N.Y.; Danby, N.Y.; Boquet R., Elizabethtown, N.Y.; Wilmington, N.Y.; Lake George, N.Y.; Blossburg, Pa.

Pteronarcys dorsata Say

(Plate 1, figs. 1-5; plate 11, figs. 173-174; plate 34, fig. 231.)

Length of body up to 40 mm.; antennae up to 23 mm.; cerci up to 17 mm.

Color dark brown, sometimes almost uniformly so, but in some specimens with lighter markings on thorax and abdomen. Head brown, with a lighter area on each side of the ocellar tri-

angle; antennal plate more prominent that in *proteus* and *biloba*, but with the outer angles broadly rounded; antennae brown, with

about seventy segments.

Prothorax much broader than long, widened posteriorly; front margin nearly straight, hind margin convex; front angles produced laterally, but rather bluntly pointed; hind angles also somewhat produced. Legs stout; femur, tibia, and tarsus fringed with

hairs. Wing pads broadly rounded at tip.

Abdomen cylindric, brown, but with lighter markings, in some specimens so pronounced that the abdomen presents a striped appearance. The caudal end of the abdomen differs greatly in the sexes. In the female, the last tergite ends in a triangular conical process which is only slightly upturned. In the male, the tenth tergite is produced into a large process which turns downward and ends in a small tubercle; ninth sternite broadly rounded and produced considerably beyond tenth sternite. The cerci are long and composed of some forty-five segments.

Spring Creek, Seminole Co., Ga.; Alma, Wis.; White Pigeon, Mich.; Otter R., Portage Co., Mich.; Washington, D.C.; Sweet-

water Branch, Fla.; Fairport, Iowa.

Pteronarcys californica Newport

(Plate 1, figs. 6-10; plate 11, figs. 175-176; plate 34, fig. 233.)

Length of body up to 50 mm.; antennae up to 22 mm.; cerci up to 11 mm.

Color dark brown, sometimes with lighter spots on thorax and abdomen, and in some specimens the abdomen with longitudinal lighter stripes.

Head much narrower than pronotum, brown, with smooth, round areas on each side of ocellar triangle; occiput corrugated,

antennal plate large with the posterior angles produced into a sharp process. Antennae brown, of about seventy segments.

Pronotum much wider than long; front margin slightly convex; hind margin very convex; widened posteriorly, and with all four angles produced laterally into a long, upcurved, pointed processes; discs somewhat rugose. Fore and hind wing pads triangular and sharply pointed. Femur, tibia, and tarsus each with a thick fringe of hairs.

Abdomen cylindric, the sexes very distinct in the mature nymphs. In the female, the tenth tergite is produced into a long triangular conical process which turns upward at the tip. In the male, the tenth tergite is very large, humped up and suddenly turned down, with a sharp tooth at the tip, directed caudad; on each side near the base of the tenth tergite a swollen area; ninth sternite not at all produced.

Pecos, N. Mex.; Yellowstone R., Yellowstone Nat'l. Park; Weber R., Utah; Redwood Creek, Humboldt Co., Calif.; Poudre Canon, Col.; Boseman, Mont.; Ogden, Utah; Logan R., Utah; Volcano Creek, Calif.

Pteronarcys princeps Banks

(Plate 35, fig. 238.)

Length of body up to 38 mm.; antennae up to 16 mm.; cerci up to 11 mm.

General color dark brown, sometimes with a few lighter spots on the abdominal segments.

Head much narrower than pronotum; surface somewhat rugose; brown except the frontal M-line, the lateral rounded marks, and the line along the clypeal-labral area, all of which are yellowish.

Antennae uniformly brown, and composed of about sixty segments. Antennal plates low and inconspicuous.

Pronotum much wider than long, a little widened posteriorly; all angles produced into short blunt processes, the front ones being directed outward and the hind ones rearward; surface rugose. Wing pads broadly rounded. Abdomen cylindric; brown, but in some specimens with small lighter dots on the tergites. Cerci brown, somewhat lighter toward the tip, and containing about forty segments.

The sexes are readily recognized, and in the structural characters of the abdomen, the nymphs are very similar to *Pt. californica*, but they are readily distinguished from *californica* by the more bluntly pointed wing pads, the shorter prothoracic processes, and the blunt supra-antennal tubercles.

Seemann (51) records this species from California, and states that she collected one adult and numerous nymphs. The adult male was determined by Dr. Needham as Pt. princeps, and Mrs. Seemann assumed the nymphs to be of the same species. I have the nymphs which she collected in Andreas Canyon, Cal., and the above description has been made from these specimens. Inasmuch as princeps and californica are very closely related, and inasmuch as these nymphs are very similar to those of californica and yet show specific differences, I feel quite certain that the identification is correct.

Pteronarcys sp.

I have before me a unique Pteronarcys nymph which was collected from the Boquet River, Elizabethtown, New York, July 20, 1929 by Mr. Sid Robinson. This nymph is not fully grown, and measures only 16 mm. in body length. It is most closely related to *Pt. biloba*, but differs from *biloba* in several respects. The color is almost black, with a yellow, transverse elongate spot on each side of the posterior margin of the pro-, meso-, and metanotum. Antennae blackish, with a yellow band in the middle, and yellow at the tips. Cerci also with a middle yellow band. At the base of the mesothoracic wing pad there is a sharp lateral spine, and the wing pads are sharply pointed. Abdominal segments one to seven with large lateral hooks, and just a suggestion of a hook each side of the eighth segment.

The spine at the base of the mesothoracic wing pads, the coloration, and the absence of hooks on the eighth abdominal segment preclude this from *biloba*. It may possibly prove to be *Pt. comstocki* Smith.

Genus PTERONARCELLA Banks

This genus is very closely allied to Pteronarcys, but the nymphs, when fully grown, are much smaller (not over one inch in length), and are readily distinguished from Pteronarcys by the fact that, in addition to having tufted gills on the first two abdominal segments as in Pteronarcys, they also have tufted gills on the third abdominal segment. The genus occurs only in the Western States.

Color nearly uniform brown, mostly with inconspicuous lighter markings, and sometimes with light longitudinal lines on the abdomen.

Head much narrower than prothorax; brown, sometimes with a blacker area over the ocellar triangle, and with a rounded light spot on either side of the ocellar triangle; three small ocelli arranged in an equilateral triangle; antennae about as long as pro-, meso-, and metathorax together, composed of fifty or more segments in the mature nymph; antennal plates narrow and low. Mouth parts of the herbivorous type, very similar to those of Pteronarcys.

Pronotum much wider than long with broadly rounded angles, and with the lateral margin flaring out considerably; discs brown and somewhat rugulose, the lateral margins smooth and lighter in color. Meso- and metanotum brown; wing pads large in mature nymphs, and extending out far from the body. Legs quite stout;

femora and tibiae fringed with hairs, first segment of tarsus about twice as long as second, third segment about twice as long as one and two combined; two large tarsal claws.

Abdomen cylindric, segments smooth, tenth segment narrow below, and above produced into a triangular pointed conical process in both male and female; cerci nearly as long as abdomen, composed of thirty or more segments in the mature nymph, somewhat hairy and each segment with a whorl of short spines at the distal end.

In the mature nymph we find seventeen pairs of tufted gills which are located as follows: three pairs in the cervical region; a small pair on the antero-lateral margin of the front legs; four pairs encircling the body just posteriorly to the front pair of legs; one pair between the mesothoracic legs; three pairs located back of the base of the mesothoracic legs; one pair between base of the metathoracic legs; one pair on the postero-lateral margin of the metathoracic legs and one pair on each of the first three abdominal segments.

This genus occurs only in the Western States. *Pteronarcella badia* was reared by Dr. J. G. Needham from nymphs collected in Logan River, Logan, Utah, the adults emerging June 23, 1926. These are the only rearing records of the genus, but fortunately mature nymphs in which the adult genital characters could be distinguished have enabled me to identify also the immature stages of *Pt. regularis*.

The nymphs are herbivorous, and from their body form and general structure, I would infer that they generally inhabit the smaller spring brooks where much dead and decaying vegetable matter accumulates.

Key to the Nymphs of Pteronarcella

1. Filaments of gill tufts long; at least twice as long as the basal conical process of gill tufts....badia Hagen (p. 35)
Filaments of gill tufts short; less than twice as long as bases of gill tufts.............regularis Hagen (p. 36)

Pteronarcella badia Hagen

(Plate 2, figs. 22-26; plate 12, figs. 177-178; plate 13, fig. 185.)

Length of body up to 21 mm.; antennae up to 9 mm.; cerci up to 9 mm.

Color almost uniformly brown but often with lighter markings on the abdomen.

Head much narrower than pronotum, brown, sometimes with

a dark, squarish mark over the ocellar triangle; a pair of lighter marks each side of the ocellar triangle; occiput slightly rugulose;

antennae of about forty-five segments.

Pronotum-nearly twice as broad as long; brown, with lighter lateral margins; discs somewhat rugose; angles broadly rounded; front margin nearly straight, hind margin somewhat convex in the central area. Legs brown, the tips of the femora and the tarsi yellowish. Femora and tibiae fringed with hairs.

Abdomen cylindric, uniformly brown or with three, more or less distinct, longitudinal lighter lines; tenth abdominal segment produced into a sharp conical process in both sexes; cerci composed of some twenty-two segments. Seventeen pairs of tufted gills, which are considerably longer than in *Pt. regularis* and are

arranged as described under the genus Pteronarcella.

There seems to be very little difference in the size and structure of the nymphs of the two species of Pteronarcella. Pt. badia has longer gills than Pt. regularis but otherwise the nymphs appear very similar. Pt. regularis probably has a somewhat wider fringe of hairs on the tibiae and femora than Pt. badia.

Reared specimens of *Pt. badia* from Logan, Utah, and mature nymphs of *Pt. regularis* from Colorado, in which the developing genital plate of the female could be clearly seen, have enabled

me to separate the two species.

I also have three juvenile forms which apparently are $Pt.\ badia$ because they have been collected in Logan, Utah, where the reared specimens of this species were found. These specimens measure 5 mm. in length. The nymphs have large spines on the legs, thorax and abdomen but seemingly not as numerous as in regularis. There are nine pairs of gills located similarly to those in the 3.5 mm. size of $Pt.\ regularis$. The antennae have about twenty-three segments and the cerci about twelve segments.

Pteronarcella regularis Hagen

(Plate 12, figs. 179-180.)

Length of body up to 21 or 22 mm.; antennae up to 9 mm., or as long as the entire thorax; cerci up to 9 mm.

Color brown with some lighter markings, especially noticeable

on the abdomen of some specimens.

Head much narrower than prothorax, brown, with lighter rounded marks outside the ocellar triangle; occiput somewhat lighter, and with faint reticulated markings; antennae of some forty-five segments.

Pronotum almost twice as wide as long; angles broadly

rounded; front and hind margins nearly straight, sides flaring; discs of pronotum somewhat rugose; lighter areas on lateral margins, as well as near the front and posterior median areas. Meso- and metanotum likewise with lighter spots. Legs brown; tips of femora and the tarsi lighter; femora and tibiae with a fringe of whitish hairs.

Abdomen cylindric, brown, with three more or less distinct longitudinal stripes on the dorsum, one in the center and one on each side along the median area of the lateral fields; tenth tergite produced into a triangular process in both sexes. Cerci composed of some twenty-five segments.

The gills are arranged as in *Pt. badia* but the individual filaments of the tufts are shorter than in *badia*.

In the maturer nymphs, the genital characters, especially the genital plate of the female, can often be observed underneath the nymphal chitin, and thus specific identification becomes very simple.

I have two juvenile forms from Estes Park, Colorado, which probably belong to this species, although the specimens differ much in appearance and structure from mature nymphs of either badia or regularis. One of these nymphs is only 3.5 mm. long. The most striking feature of this specimen is its spiny body. The femora and tibiae are covered with large spines, as are also the lateral margins of the meso- and metanotum and the abdominal segments. There are only nine pairs of gills, and these are located as follows: one pair anterior, and two pairs posterior to the prothoracic legs; one pair between, and one pair posterior to the mesothoracic legs, and one pair on each of the first three abdominal segments. The antennae are composed of fifteen segments, and the cerci of thirteen segments.

The second juvenile form measures 6.5 mm. in length, and resembles the smaller specimen in that the legs are covered with large spines. However, the spines on the thorax and the abdomen are fewer in number; the antennae are composed of twenty-eight segments and the cerci of sixteen segments. In this specimen there are ten pairs of gills distributed as in the smaller specimen except that there are two pairs anterior to the prothoracic legs, instead of one pair as in the smaller form. Inasmuch as these two specimens were collected in the same locality and at the same time as the mature nymphs of *Pteronarcella regularis*, it seems very probable that they are the same species. Furthermore, it would indicate that the life cycle of this species occupies two years.

PELTOPERLIDAE new family

The genus Peltoperla has heretofore been placed in the family Perlidae. In a general way the adults are not greatly different from the adults of the other genera of the Perlidae, but the nymphs are so unique in structure and so unlike in habits from other genera that it seems best to place this genus in a separate family.

The nymphs of Peltoperla are herbivorous while the nymphs

of all the other genera of the Perlidae are carnivorous.

The Peltoperlidae are readily recognized in the immature stages by the roach-like form of the nymphs; the large shieldlike pro-, meso-, and metanotum; short abdomen; very wide legs; short cerci; and the short head bent under the body. The mouth parts are of the herbivorous type, and similar in structure to the mouth parts of Pteronarcidae.

The family is represented by a single genus Peltoperla which is distributed over the Eastern, Southern and Western States.

Genus PELTOPERLA Needham

The nymphs of this genus are readily recognized by their roach-like form. Body broad and flattened; the thorax consists of large brown chitinized plates which extend laterally over the side of the body; the head is curved under so as to be only partly visible from above; the abdomen is very short, with usually not more than five or six segments visible from above; on the underside, the thorax consists of three large plate-like shields representing the pro-, meso- and metasterna; the legs are broad and flattened.

The wing pads are not clearly defined, but are present as continuations of the meso- and metathoracic tergites; legs broad and short; coxa very broad and posteriorly produced into a rounded lobe; femur with a deep groove on the inner margin, into which the tibia fits when the leg is folded; first and second tarsal segments short, subequal, and the two together less than half as long as the third segment.

Gills, when present, occur as single fleshy filaments attached under the meso- and metasterna. According to Uéno, these filaments are attached to the coxae but in Peltoperla arcuata they are outgrowths of the meso- and metaplurae and originate near

the base of the legs.

The sexes are very similar in the nymphs but the females may

be recognized by a small median notch on the hind margin of the eighth abdominal sternite.

The mouth parts are of the typical herbivorous type: labrum wider than long, densely covered with hairs, especially on the anterior margin; mandibles broad and asymmetrical, each mandible with four or five unequal teeth followed by a broadened molar which is slightly hairy or spinulose, and beyond this a bunch of long hairs; maxillae broad; lacinia bidentate, the second tooth nearly as long as the first, followed by a row of long hairs; galea broad, flattened, somewhat hairy, and at the tip a bunch of rather long hairs; maxillary palpus considerably longer than the lacinia; labium with a large, wide submentum; mentum a narrow transverse band; the glossae shorter than the paraglossae and beset with long hairs; the three-jointed labial palpus, when fully extended, reaches beyond the tip of the paraglossae; hypopharynx rounded and produced normally to the tip of the glossae.

The nymphs of this genus are herbivorous and are usually found in small fresh-water spring brooks where the current is quite slow, and where dead leaves and debris accumulate. In such localities Peltoperla may usually be found in considerable numbers. By collecting a handful of leaf-drift and sorting it carefully, one can usually find these roach-like nymphs. *P. arcuata*, which is the most common species in the vicinity of Ithaca, apparently has a two-year life cycle.

I have many nymphs collected from various localities, and all of these agree with the above generic description, but *P. arcuata* is the only species in the genus which has been reared to maturity. The other nymphs, I have been unable to identify to species.

Peltoperla arcuata Needham

(Plate 2, figs. 27-32; plate 12, figs. 183-184; plate 14, figs. 186-187.)

Length of body up to 9 mm.; antennae up to 6.5 mm.; cerci up to 3 mm.

General color chestnut-brown, with somewhat lighter areas on the prothorax, antennae, legs, and cerci.

Because of the deflexed condition of the head, it appears to be very wide and short. The head is much narrower than the pronotum, and is bent over to such an extent that the clypeus and labrum are directed rearward underneath. The color of the head is uniformly brown except for a little lighter area around the compound eyes, which are black and rather small; epicranial suture very distinct; hind ocelli black, plainly visible, and about as far from each other as from the inner margin of the compound eyes; front ocellus only indicated by a small depression; surface smooth, with a feeble coating of fine hair; antennae light brown

in color, of fifty or more segments.

Pronotum about twice as wide as long; front and hind margins nearly straight, much widened posteriorly; hind angles very broadly rounded; front angles narrowly rounded; surface smooth and densely coated with hairs, the postero-lateral angles with branches of long hairs; the marginal groove in this species represented only back of the anterior margin; meso- and metanotum longer than the pronotum, and slightly wider; surface smooth, but with a general coating of fine hairs, and with longer spinelike hairs on the lateral margin, as well as on the surface toward the lateral margin.

Legs broad, short, and spiny; the coxa broad, and the outer areas produced into a rounded lobe margined with long hairs, the inner part of the coxa bears on the distal end a row of long spines, and another shorter row of spines farther back; trochanter somewhat triangular, with a row of spines at the distal margin; femur about half as wide as long, on the inner margin with a deep groove; on the outer margin with a fringe of hairs, and on the surface with numerous short hairs and spines; tibia a little shorter than the femur, with many short spines, and on the outer margin with a fringe of long hairs; first two segments of tarsi short, subequal, and the two together less than one-half as long as the third.

Abdomen flattened; all except the last four or five segments usually covered with the large metanotum; posterior margin of the abdominal segments with a fringe of spines which are especially long on the last segment; cerci rather stout at the base, gradually tapering to a slender point and made up of about twenty-five segments.

The pro-, meso- and metasterna developed into large flat

shields.

The five pairs of filamentous gills are located as follows: two pairs at the outer base of the mesothoracic leg almost completely covered by the mesonotum; two pairs on the metathorax; and one pair on the underside of the metasternum, located at a point half way between the base of the leg and the postero-lateral angle.

This species occurs in the Eastern States where the nymphs may be found in small spring brooks among the leaf drift and debris.

Many reared nymphs from Ithaca, N.Y.

Family PERLIDAE

This family includes most of the more brightly or strikingly colored nymphs. They are all carnivorous. Head as wide or slightly wider than pronotum; either two or three ocelli; epicranial suture distinct; clypeo-frontal suture absent; antennae long and slender. Pronotum much wider than long, variously marked. Meso- and metanotum with the wing pads either only slightly produced and indistinctly set off from the body, or the wing pads may be produced into long, distinct appendages, Gills either present or absent. When present they may be small and finger-like (Perlodes), and attached to the submentum or thorax, or the gills may be present as tufted branches on the thorax, and in some cases tufted gills are also found attached to the subanal lobes between the cerci. The cerci are long and slender and made up of many segments. The mouth parts are of the carnivorous type and therefore differ in structure from the mouth parts of the other families.

The labrum is very short and wide and bears a distinct epipharynx which is very flexible and may be extended or retracted.

The mandibles are quite narrow, and beyond the teeth there is a fringe of hairs, but no molar. The maxillae also differ in structure from the maxillae of other families. The lacinia terminates in a long sharp incurved tooth, and in most cases possesses a second long tooth. The galea is much reduced.

The most striking feature of the labium is the unequal size of the glossae and the paraglossae. The glossae are reduced to small lobes, while the paraglossae are developed into very large lobes. The hypopharynx is normally produced to or beyond the tips of the glossae.

The genera belonging to this family are such a varied lot that very little can be said about the general biology which will apply to the entire group. The majority of the genera are found in rather swift running water.

Genus PERLODES Banks

Stoneflies of this genus are restricted to the Rocky Mountain region and the Western States. The nymphs are recognized by the presence of a pair of small, single, finger-like, tracheal gills which are attached to the outer, lower base of the submentum of the labium. In addition to this pair of gills, some species of the genus have the same type of gills on the conjunctivae on the ventral

side of the prothorax. The head is very thick and the maxillae are very large, bulging out each side of the head so as to be visible from above. General color yellowish brown with yellow markings. Three occili-placed in a triangle of which the base is longer than the sides; eyes medium in size; a more or less plain occipital ridge is noticeable, composed largely of short stout brown hairs; epicranial suture distinct.

Pronotum narrower than head, wider than long, with broadly rounded angles; surface of pronotum somewhat rugulose; mesoand metanotum marked similarly to pronotum; wing pads almost parallel to body; legs with a fringe of long fine hairs on the femora and the tibiae; first and second tarsal segments very short, subequal; one and two together not over a fourth as long as third.

Abdomen slightly flattened; tenth tergite triangularly produced; cerci more than a third as long as the body, with a fringe of hairs on the dorsal surface, and each segment ending in a

whorl of short hairs.

The mouth parts are of the typical carnivorous type, the most conspicuous feature in which they differ from other genera of the Perlidae being the structure of the maxillae and labium.

Labrum about three times as wide as long, anterior margin with long hairs, and with many others on the ventral surface.

Mandibles slightly asymmetrical, each mandible having five or six teeth, placed in two groups, one of three, and the other of three or two. Following the teeth there is a fringe of hairs on the inner margin, and also a row of hairs on the ventral surface and one on the dorsal surface.

Maxillae very large; lacinia wide at base and bidentate, with the second tooth not much more than half as long as the apical one; galea slender and cylindric, with a small, membranous, attenuated, spinulose tip; palpus five-segmented; cardo and stipes

very large and massive.

Labium: glossae small and rounded; paraglossae large, pear-shaped, and directed inward, with a membranous spinulose tip; mentum a narrow transverse band; submentum large and bearing at each outer, basal corner a small single gill; hypopharynx broadly rounded, and at the apex closely beset with fine bristle-like hairs.

Nothing is known about the biology of this genus. No specimens have been reared, and identification of the species treated in this paper was made possible by studying the genital structures in mature nymphs. The structure of the nymphs would indicate

that they live in swift water, are carnivorous, and probably have a two-year life cycle.

Key to the Nymphs of Perlodes

- 2. Four pairs of finger-like gills; one pair on submentum, three pairs on the sides of the thorax.....signata (p. 43)

 Three pairs of finger-like gills; one pair on submentum and two pairs on thorax......tibialis (p. 44)

Perlodes signata Hagen

(Plate 12, figs. 181-182.)

Length of body up to 28 mm.; antennae up to 10 mm.; cerci up to 10 mm.

General color yellowish brown, varied with yellow markings; the brown accentuated by the presence of an irregular coating of short brown hairs.

Head about as wide as long, thick, with very large maxillae which protrude each side so as to be visible from above; three small ocelli arranged in a triangle whose base is greater than its sides; yellow frontal M-line distinct; a yellow mark each side of the ocellar triangle; the occipital ridge meets the epicranial suture at the vertex, thus forming a triangular field on the inside of each eye, these triangles each containing a large rounded area of reticulate yellow markings; labrum and lateral portions of clypeus brown; antennae of some fifty-five segments.

Pronotum narrower than head, broader than long; front margin nearly straight; sides a little convex; hind margin convex but with the narrow marginal groove concave in center; all angles rounded; median line yellow; lateral field with yellow markings; meso- and metanotum similarly marked; wing pads almost parallel with body. Legs yellowish brown; thick fringes of long white hairs on the outer margins of the femora and tibiae; first and second tarsal segments very short, subequal.

Four pairs of single small, finger-like gills located as follows: one pair at the outer base of the submentum; second pair at the outer anterior base of the prothoracic legs; third pair on the lateral margin of the conjunctivae between the pro- and meso-

sternum; and fourth pair similarly located on the conjunctivae between the meso- and metasternum.

Abdomen brownish; tenth tergite of female triangularly produced but not directed upwards, while in the male it is slightly more produced and directed upwards; cerci of twenty-five or more segments, basal segments very short, apical ones four to five times as long as wide; a fringe of hairs on the upper surface of the cerci, and each segment ending in a whorl of short hairs.

Mature nymphs from Boulder, Colorado, in which the genital characters of the adults could be readily observed, enabled me to

identify this species.

Perlodes tibialis Banks

(Plate 3, figs. 44-49.)

Length of body up to 23 mm.; antennae up to 9 mm.; cerci up to 11 mm.

Hairy nymphs, of a light brown color with markings on head and thorax; occlli and eyes small; three pairs of small, single, finger-like gills located as follows: one pair at the outer base of the submentum, one pair on the lateral margin of the conjunctivae between the pro- and mesothoracic legs, and one pair on the outer conjunctivae between the meso- and metathoracic legs.

Head slightly wider than pronotum, thick, yellowish; three small ocelli; eyes set far to side of head; frontal M-line distinct; on each side of ocellar triangle an oval mark; epicranial suture very distinct; occipital ridge distinct on sides but fading out in center; occiput with an irregular pattern due to the peculiar distribution of short brown hairs; antennae of about 70 segments.

Pronotum nearly twice as wide as long; front and hind margins slightly rounded; angles rounded, the hind ones more so than front ones; discs with a few inconspicuous rugosites; surface hairy. Wing pads broadly rounded at apex. Legs with a fringe of hairs on femora and tibiae; femora closely beset with brown hairs; first and second tarsal segments short, subequal; third segment about four times as long as one and two combined. Abdomen somewhat flattened; cerci with twenty-five to thirty segments, each tipped with a whorl of short spines.

Mt. Rainier, Wash.

Perlodes americana Klap.

Length of body up to 24 mm.; cerci up to 14 mm. General color yellowish brown.

This species has the general appearance of *Perlodes signata* but differs in the following points: only one pair of fleshy, finger-like gills present, located at the outer base of the submentum, with no gills on the thorax. Head and thorax almost entirely devoid of a coating of short brown hairs; fringes on femora and tibiae thicker than in *signata*, and dorsal fringe of hairs on the cerci, also, thicker.

There is a single female nymph without locality label in the collection with the mouth parts and antennae removed but the structure of the subgenital plate is so clearly indicated that specific identification is possible.

Genus ISOGENUS Newman

The nymphs of this genus resemble those of Perlodes, however, they possess no gills.

When fully grown, the nymphs measure less than 25 mm. in body length. General color yellowish brown to brown. Head a little wider than pronotum; three ocelli; long antennae. Pronotum about twice as wide as long; angles rounded; a wide median yellowish longitudinal stripe with embossed markings on each side; marginal groove distinct and about equally distant from the margin all around. Wing pads quite large in mature nymphs. Legs rather long, slender, and with a fringe of long hairs on the outer margin. First and second tarsal segments very short; tarsal claws with a basal tooth. Abdomen somewhat flattened, cerci long and slender. Gills absent. Mouth parts typically carnivorous.

Isogenus colubrinus (?) Hagen

(Plate 3, figs. 39-43.)

Length of body up to 22 mm.

General color yellowish brown with darker markings on head and pronotum.

Head a little wider than pronotum; a reticulate area on each side of the occiput; occipital ridge indicated by a row of spinules on each side, but totally absent in the central portion over the stem of the epicranial suture; occili small, the hind occili closer to each other than to the eyes; a yellowish spot within the occilar triangle. Pronotum twice as wide as long; a wide median yellowish longitudinal stripe with embossed markings on each side; hind angles more broadly rounded than front ones; marginal grooves quite distinct all around and equally near the margin on sides and front.

Wing pads long, rather slender, and pointed. Legs long, quite slender and fringed with long hairs; tarsal claws with a small sharp basal tooth.

Abdomen moderately flattened; posterior border of each seg-

ment with a fringe of very small spinules. Gills absent.

Mouth parts: labrum at least three times as wide as long; hairy on the surface, and with a fringe of long hairs on the anterior margin. Mandibles asymmetrical, each with five unequal teeth followed by a fringe of long hairs. Maxillae: lacinia bidentate, the second tooth about half as long as apical one, followed by a series of long hairs; galea cylindric and reaching a little beyond the base of the second lacinial tooth; maxillary palpus about as long as lacinia. Labium about as wide as long; glossae small, and at the apex a small membranous tubercle; paraglossae large, hairy, and also tuberculate at the tip; labial palpi extending considerably beyond paraglossae. Hypopharynx broadly rounded and at the tip closely beset with very fine spinules.

A mature female nymph, without locality label, ready to emerge, has enabled me to identify the species with some degree of certainty. However the nymphs have been in alcohol so long that the bodies are rather badly shriveled and the color pattern

cannot be observed clearly.

Genus PERLA Geoffroy

The limits of this genus are not easy to define, for it is made up of a rather heterogeneous group of species. The known nymphs fall into two rather distinct groups. The first of these groups (capitata, media and immarginata) possess copious gills, a very distinct occipital ridge, and the body is considerably depressed. These species are typical of Perla sensu str., and agree with the

descriptions of the known European Perla nymphs.

The second group (bilobata, expansa, verticalis and aestivalis) possesses no gills, the occipital ridge is absent and the body is more cylindrical. These nymphs fall under the subgenus Hemimelaena Klap. Perla hastata Bks., which is here included in the genus Perla, was originally assigned to Isogenus by Banks, and I am rather inclined to believe that the nymphs, and possibly the adults, are more typical of Isogenus than of Perla. However, I shall not attempt in this paper to revise or change the nomenclature of any of the genera from that adopted by Needham and Claassen (27). It is evident that some changes will have to be made as soon as the immature stages of the various species are

better known, especially in the genus Perla, in order to arrange the species in more natural groups.

Key t	to the	Nymphs	of	Perla
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	,
1.	Gills present
	Gills absent
2	Caudal gills present
	Caudal gills absent 3
3.	Almost uniformly brown; abdomen not banded with yellow
	and brown; no yellow spot in the ocellar triangle
	Brightly patterned with yellow and brown or black; abdomen
	banded with yellow and brown; a yellow spot in the ocel-
	lar triangle
4	Lacinia composed of a single long tooth; galea very small, less
	than half as long as lacinia 5
	Lacinia bidentate; galea at least half as long as lacinia 6
5.	Western; length of mature nymphs 16 mm.; a narrow dark
	line around margin of pronotumexpansa (p. 55)
	Eastern; length 10 mm.; apparently no dark line around
	pronotumbilobata (p. 54)
6.	Occiput of head, each side, with a roundish mottled area
	bounded by a darker margin
	Not so 7
7.	Head with a wide dark transverse band; pronotum yellow
	in center and dark all around; abdomen banded with yel-
	low and brown or yellow and black verticalis (p. 57)
	Not so

Perla capitata Pictet

(Frontispiece; plate 31, fig. 220.)

Length of body up to 23 mm.; antennae up to 11 mm.; cerci up to 14 mm.

These brightly colored yellow and brown or yellow and black nymphs are easily recognized by the two dark transverse bands across the head, the two dark transverse bands on the femora, the presence of caudal gills and the yellow and dark banded abdomen.

Head a little narrower than pronotum; occipital ridge distinct; hind ocelli at least twice as close to each other as to the eyes; the wavy dark transverse band which passes through the ocellar triangle extends backward in the middle to the hind ocelli, or slightly beyond, but usually bears a V-shaped yellow area between

them; labrum dark brown; antennae yellowish, about half as long as the body and composed of about eighty-five segments.

Pronotum nearly twice as wide as long, slightly widened posteriorly; hind angles more broadly rounded than front ones; front margin a little convex, hind margin slightly concave in the middle; surface covered with fine hairs; margin bordered with short spinules; marginal groove more distinct on front and hind border than on lateral margins. Meso- and metanotum and wing pads covered with fine hair, and the margins of the wing pads with fine spinules. Legs flattened; femora with a dark blotch or transverse band at the basal and distal ends; legs with a

thick fringe of long whitish hair on the outer margin.

Abdomen flattened; basal half of tergites one to nine yellowish, the posterior half brown or blackish; the tenth tergite brown or blackish at the base and at the sides but with the central apical portion yellowish. The extent of the darker color varies considerably but even in the darkest specimens, in which almost the entire tergites are brown or blackish, the tenth tergite is yellowish at the apex. Dorsum of abdomen pilose, each tergite bearing on the posterior margin a fringe of short spinules. Cerci reddish brown, about two-thirds as long as the body and composed of about fifty-five segments, each segment terminating in a whorl of short spines. Ventral surface of abdomen yellow except for a little brown on the abdominal segments, especially the posterior ones.

Eight pairs of bunched tracheal gills, arranged as in *P. immarginata*, except that the nymphs of *P. capitata* possess, in addition to the thoracic gills, one pair of caudal gills which are attached to the subanal lobes between the cerci. The mouth parts do not differ materially from those described under *P. immarginata*.

New York: Ithaca; Dansville; Boquet R., Adirondack Mts.; Oneida Co.; Potomac R., Brunswick, Md.; Harper's Ferry,

W.Va.: Plummer's Island, Md.; Guelph, Ont.

Perla media Walker

(Plate 16, fig. 190; plate 33, fig. 228.)

Length of body up to 22 mm.; antennae up to 10 mm.; cerci

up to 14 mm.

The general color of these nymphs is yellowish brown to dark brown or almost black. The immature nymphs are generally almost uniformly brown, with a coating of long fluffy hairs on the head and thorax; while the mature nymphs usually exhibit various degrees of contrasting patterns on the head and thorax and are usually without the coating of long hairs. Two characters by which this species may be identified are the uniform brown color of the abdomen, and the even curvature of the occipital ridge. The species most likely to be confused with *P. media* are *Acroneuria ruralis*, and *A. abnormis*. In *A. ruralis*, however, the cerci are longer than the body, and the occipital ridge does not follow an even curve, but tends to be broken, and in the center is directed inward toward the occilar triangle. In *A. abnormis* there is no occipital ridge.

Head slightly narrower than pronotum; occipital ridge uniformly distinct, evenly curved forward and in the center reaching almost to the arms of the epicranial suture; hind ocelli nearly twice as close to each other as to the eyes; each of the three ocelli usually with a lighter area at the outer angles of the ocellar triangle and a yellowish spot each side. Antennae about half as

long as body and composed of about ninety segments.

Pronotum about twice as wide as long, in some specimens a little more; surface pilose; margin with a fringe of hairs which are longest on the posterior margin; the markings on the lateral fields of the pronotum vary considerably in intensity or distinctness, but usually show up more plainly in the maturer nymphs; marginal groove distinct in front and behind; hind angles more broadly rounded than front angles. Meso- and metanotum with surface more hairy in young than in older nymphs.

Legs flattened, with a wide fringe of long white hairs.

Abdomen quite uniformly brown and thickly covered with short spinules. Cerci about two-thirds as long as body, with a fringe of long hairs on the inner side, especially on the basal portion, composed of about thirty-six segments, each ending in a whorl of spines.

Seven pairs of gill tufts arranged as in P. immarginata. Anal

gills absent.

The sexes may be distinguished, in the more mature nymphs, by the developing genital characters, but in the younger speci-

mens they cannot readily be separated.

As already stated, there is considerable variation in the intensity of the color pattern. In some of the younger nymphs, especially, the general color is almost uniformly brown, and the lighter markings on the head and thorax are only faintly indicated. The younger nymphs are also more hairy than the older ones. These long hairs are especially noticeable on the occipital

ridge of the head, the posterior margin of the pronotum, the posterior margin and medical portion of the meso- and metanotum, and along the mid-dorsal line of the abdomen. In many nymphs, these hairs became coated with a brown slimy ooze and this gives

the specimens a dirty, fuzzy appearance.

In the very small nymphs (5 to 7 mm. in length) there are only three pairs of gill tufts present. These correspond to the three largest pairs in mature nymphs. In these small specimens the pronotum bears a fringe of long spines; the meso- and metanotum and the abdomen are covered with long spines as well as the femora, which in the young forms are very wide. The occipital ridge, however, is very distinct, and this, together with the uniformly brown color of the abdomen, makes identification of this species possible even in the very young stages.

This species occurs under stones in the larger streams, but the nymphs apparently are able to live in somewhat quieter waters than the nymphs of P. immarginata, for mature nymphs of P. media have on several occasions been collected from the waters of Beebe Lake, on the Cornell University campus, as well as from Dwyer's pond, in Cascadilla creek. It is interesting to note that, whereas the adults of the above two species are very similar in general appearance and it is at times difficult to separate the females, the nymphs are very different in general appearance, the nymphs of P. media being dull brown, while those of P. immarginata possess a very striking color pattern.

P. media is a typical carnivore and probably requires three

years to complete its life cycle.

Ithaca, N.Y.; Ogdensburg, N.Y.; Potomac R., Harpers Ferry, Md.; Cleveland, Va.; Guelph, Ont.

Perla immarginata Say

(Plate 5, figs. 77-82; plate 31, fig. 219.)

Length of body up to 33 mm.; antennae up to 15 mm.; cerci up to 22 mm.

This is the largest and one of the most beautiful nymphs of

this genus in the Eastern States.

It is almost impossible to describe the details of the striking yellow and brown, or yellow and blackish color pattern, but the photograph (Plate 31, fig. 219) illustrates this very well, and an attempt will be made here only to point out some of the more striking patterns which aid in identification of this species. It

will also be necessary to point out something of the limits of variation in color pattern within the species.

The pattern on the head varies somewhat, but normally there is an oval white spot in the center of the dark mark which covers the ocellar triangle. There is always a long, dark elongate mark on each of the femora. This mark extends about two-thirds of the length of the femur, and at the distal end there may be seen on the inner side (sometimes on both sides) another small dark blotch. The abdomen is alternately barred with yellow and black or yellow and brown, the basal half of each segment being dark and the caudal half light. Here is to be found considerable variation, for in the darker specimens the entire segments are sometimes almost equally dark, but I have never yet seen a nymph of this species in which the tenth tergite was not yellowish at the apex, and in most most nymphs this yellow color cuts into the basal dark band in a V-shaped manner.

Head slightly narrower than the pronotum; the occipital ridge very prominent; epicranial suture distinct; hind occili closer to each other than to the eyes; antennae more than half as long as body and made up of about ninety segments.

Pronotum almost twice as wide as long; somewhat widened posteriorly; hind angles much more broadly rounded than front ones; front margin nearly straight, hind margin slightly concave in the center; surface feebly pilose, and the margin with a fringe of very short spinules; marginal groove distinct in front and behind, and more or less continuous around the entire pronotum.

Meso- and metanotum, including wing pads, with scattered hairs and the margins of the wing pads with a fringe of fine spinules.

Abdomen flattened; tergites with a fringe of spinules on the posterior margin; surface with scattered short hairs and with longer hairs along the mid-dorsal line. This line of long hairs is especially noticeable in the half-grown and smaller nymphs where these hairs are especially thick on the caudal segments. The cerci are about three-fourths as long as the body and are composed of fifty or more segments, each segment terminating in a whorl of short spines. On the inner dorsal margin the cerci bear a fringe of long fine hairs, which are longest near the base of the cerci.

The legs are much flattened and bear a thick fringe of long, fine, whitish hairs on the outer margin.

Ventral surface of body quite uniformly yellowish. Seven pairs

of compound gill tufts distributed as follows: two pairs at the outer base of the prothoracic legs just underneath the lateral shields of the pronotum; one pair each in a similar position on the meso- and metathorax; one pair each on the outer conjunctivae between the pro- and mesosternum, and between the meso- and metasternum; and one pair just back of the base of the metathoracic legs. Anal gills absent.

The sexes are not readily distinguished; however, in the maturer nymphs the females may be recognized by the small median notch on the posterior margin of the eighth abdominal sternite, and often the abdomen is seen to be distended with dark eggs.

Mouth parts: labrum about three times as wide as long, with a fringe of long hairs on the anterior margin; epipharynx broadly rounded when fully extended, and closely beset with short spines. Mandibles triangular and rather slender, somewhat asymmetrical, each with five unequal sharp teeth, followed by a fringe of long hairs. Maxillae: lacinia long and slender and terminating in two long sharp teeth; following these teeth, a fringe of long, stout hairs. Galea slender, two-segmented, tipped with papillae and a few long hairs, and not reaching quite to the tip of the lacinia; maxillary palpus slender and extending somewhat beyond the tip of the lacinia.

Labium wider than long; submentum very large, mentum a narrow transverse band; glossae very short and broadly rounded; paraglossae large, somewhat pear-shaped and directed inward; both glossae and paraglossae hairy and at the tips closely beset with papillae. Hypopharynx thickly covered with short spinules.

The nymphs of this species are common in the larger swiftwater streams with stony bottoms. They restrict themselves largely to the underside of stones and are able to maintain a foothold in very swift currents of water. They are voracious feeders, feeding on mayfly nymphs, midges, blackfly larvae and pupae, and even on stonefly nymphs. Examination of stomach contents also reveals the presence of many diatoms which, however, are probably ingested incidentally while feeding on animal prey. Miss Smith (52) found that in the younger stages the nymphs of this species apparently ingested a greater number of diatoms than they did as they grew larger, and this would indicate that during the early stages diatoms form part of the preferred diet of these nymphs.

No one has worked out the complete life history of this species, but it apparently requires three years to complete its life cycle.

New York: Ithaca; Dansville; Wilmington; Moffitsville; Allegany Co.; Montgomery, Mass.

Perla aestivalis (?) Needham and Claassen

Length of body up to 11 mm.; antennae up to 5 mm.; cerci up to 5 (?) mm.

General color vellowish brown, with the outer margin of the pronotum dark, and with the basal half of the abdominal tergites darker than the caudal half. Head a little wider than pronotum, quite smooth, and almost equally brown all over; ocelli large, the hind ones nearly twice as close to the eyes as to each other; occipital ridge absent; antennae composed of about fifty segments. Pronotum about twice as wide as long, transversely oval, with the angles broadly rounded; surface nearly smooth; marginal groove dark and very distinct all around. Wing pads long, set far apart, and lying almost parallel with the body. Legs long, slender, and not much flattened; a fringe of long hairs on the outer margin; femora with rather few hairs on the upper surface: third segment of tarsus very long, about half as long as tibia: tarsal claws with a prominent, sharp, basal tooth. Abdomen somewhat flattened, smooth, and with a fringe of spinules on the posterior margin of each tergite; cerci with the tips broken off, but one of the nymphal skins shows twenty segments, and the total is probably twenty-five to thirty.

Gills absent.

Mouth parts of the carnivorous type. Labrum three times as wide as long; front margin with a fringe of long hairs. Mandibles rather slender, with four unequal teeth, followed by a fringe of long hairs, and beyond this fringe the mandibles somewhat excavated or broadly notched. Maxillae: cardo very short; stipes as long as lacinia; lacinia broad at base, bidentate, the second tooth only half as long as the long terminal one and followed by only a few long hairs; galea feebly developed, cylindrical and only about half as long as lacinia; maxillary palpus longer than lacinia, its apical segment very slender. Labium longer than wide; glossae short, triangular, and produced into blunt tubercles which are closely beset with papillae; paraglossae large, hairy, directed inward, and bearing at the tip tubercles similar to those of the glossae; labial palpi extending far beyond paraglossae. Hypopharynx rounded and closely beset with short stiff hairs.

Described from three nymphal skins and one female nymph, taken at the same time and place as were the male holotype and the female allotype, Yellowstone Park, July 14, 1921. R. Muttkowsky.

Perla bilobata Needham and Claassen

(Plate 4, figs. 50-54.)

Length of body up to 9.5 mm.

General color yellowish-brown, with the pronotal marginal

groove dark brown.

Head wider than pronotum; quite smooth, occipital ridge absent; hind ocelli closer to the eyes than to each other; tips of antennae broken off in the specimens before me but one partial antenna has thirty-eight segments, so that the full number is

probably near fifty.

Pronotum about twice as wide as long; transversely oval; marginal groove distinct, brown, continuous around entire pronotum, and equidistant from the margin all around. Wing pads large and only slightly divergent from the body. Legs not much flattened; with only a sparse fringe of hairs on the outer margin; tarsal claws with a distinct basal tooth.

Abdomen not much flattened; segments with a fringe of spines and a few long hairs on posterior margin; segments of cerci tipped with a whorl of long stout hairs.

Gills absent.

Mouth parts: labrum at least three times as wide as long, covered with hairs and with a fringe of long hairs on the anterior margin. Mandibles with four or five unequal teeth followed by a fringe of long hairs, and beyond this fringe there is a deep, rounded notch. Maxillae with very long stipes; lacinia broad at the base, on the inside a large rounded knob, narrowing immediately to a long, single, smooth, incurved tooth, the entire sclerite devoid of hairs; galea much reduced, hardly a third as long as lacinia, and at the apex one long hair; maxillary palpus slender and extending somewhat beyond the tip of the lacinia. Labium a little longer than wide, and very similar in structure to that of *P. aestivalis*; glossae short; paraglossae large, hairy, and directed inward; both glossae and paraglossae with small papillae at the tip. Hypopharynx broadly rounded and closely beset with short stiff hairs.

Described from two nymphal skins, from specimens reared by J. G. Needham, Old Forge, New York, July 13, 1905.

Perla expansa Banks

Length of body up to 16 mm.; antennae up to 6.5 mm.; cerci up to 8 (?) mm.

The nymphs of this species resemble very closely those *P. bilobata*, but are larger in size and differ in a few details of structure. General color yellowish with a narrow brown marginal groove around the pronotum. Head much wider than pronotum; maxillae extending far out beyond the outer margin of the eyes, greatly accentuating the width of the head; hind ocelli about as close to the eyes as to each other; occipital ridge absent.

Pronotum transversely oval, almost twice as wide as long; marginal groove dark and continuous around entire pronotum. Legs slender, with a distinct but rather feeble fringe of fine hairs; tarsal claws with a small basal tooth. Abdomen not much flattened; each segment with fine spinules on the posterior margin.

Gills absent.

Mouth parts very similar to those of *P. bilobata*, but the lacinia narrows down more gradually in *expansa* than in *bilobata*, is unidentate and devoid of any hairs; galea feeble and very short.

The sexes are readily distinguished in the more mature nymphs

by the developing genital structures.

Identification of this species was made possible by a study of the genitalia of both male and female nymphs which were collected in the Big Thompson River, Estes Park, Colorado, August 4, 1921 (P.W.C.), and from Tolland, Colorado (G.S.D.).

Perla hastata Banks

(Plate 3, figs. 33-38; plate 15, fig. 188; plate 33, fig. 230.)

Length of body up to 25 mm.; antennae up to 10 mm.; cerci up to 14 mm.

The nymphs of this species are readily recognized by the variegated pattern of yellow and brown, absence of gills, large head, which is much longer and wider than pronotum; and especially by the two transversely oblong mottled areas on the large occiput of the head. Body not much flattened.

Head at least half again as long as the pronotal disc and much wider; the cardo and stipes of the maxillae very long, and thus the maxillae protrude on the sides of the head so as to be plainly visible from above, accentuating the width of the head; ocelli set close together in a small triangle, the hind ocelli half again as close to each other as to the eyes; eyes small; occiput long, and on each side with a large transverse mottled area completely

surrounded by darker brown; no distinct occipital ridge present, although the hind margins of these mottled areas are suggestive of a ridge; frontal M-line distinct; surface covered with short brown hairs; antennae about one-third as long as body and made up of about fifty to fifty-five segments. Pronotum nearly half again as broad as long; almost transversely oval; the hind angles a little more broadly rounded than the front ones; surface covered with short brown hairs; a more or less distinct median longitudinal yellow stripe; discs with embossed markings; marginal groove distinct and equally close to margin of pronotum all around.

Front wing pads separated, parallel; hind wing pads more divergent. Legs long, slender, and not much flattened; a rather thin fringe of long hairs on the outer margin; tarsal claws each

with a distinct basal tooth.

Abdomen not much flattened, brown, but in the more brightly colored specimens the basal half of tergites one to nine each has three pairs of light spots, one being on the mid-dorsal line, and one on each side; surface of abdomen covered with short brown hairs, and the hind margin of each segment with a fringe of fine spinules. Cerci more than half as long as body, composed of about thirty-three segments, each segment terminating in a whorl of short hairs, and with longer hairs on the inner dorsal side, especially prominent on the basal part of the cerci.

Gills absent.

Mouth parts. Labrum about three times as wide as long, with a fringe of long hairs on the anterior margin. Mandibles asymmetrical; each with five unequal sharp teeth followed by a fringe of long hairs. Maxillae with a long cardo and stipes; lacinia bidentate, with a long terminal tooth and with the second tooth not more than half as long as the terminal one; below the base of the second tooth the lacinia suddenly widens in an angulate manner and bears a fringe of hairs; galea rather weak and not reaching quite to the tip of the second tooth of lacinia, and at the apex with a small but distinct hairy tubercle; maxillary palpus longer than lacinia, the last segment very slender. Labium slightly wider than long; glossae short, triangular, and at the apex a papillose tubercle; paraglossae rather narrow, converging toward the tip, bearing at the apex a small tubercle similar to that on each of the glossae; labial palpus much longer than paraglossae. Hypopharynx broadly rounded and closely beset with stout hairs.

Male. Tenth abdominal tergite broadly rounded; beyond this a short, broadly triangular membraneous tubercle in which the supra-anal process develops.

Female. Tenth abdominal tergite broadly rounded but without median tubercle; genital opening indicated on the eighth abdominal sternite.

The nymphs of this species occur in small upland spring brooks, where they may be collected under stones. I have never collected them in the large swift-water streams. The more or less cylindric shape of the body is not so well suited for inhabiting the swifter waters, and yet the total absence of gills necessitates their living in cold spring brooks in which the water maintains a steady flow and is richly supplied with oxygen.

The nymphs are carnivorous and apparently require two years to complete the life cycle.

Ithaca, N.Y.

Perla verticalis (?) Banks

(Plate 4, figs. 55-59; plate 15, fig. 189.)

Length of body up to 12 mm.; antennae up to 6.5 mm.; cerci up to 7.5 mm.

General color yellow with a wide blackish transverse band across the head; pro-, meso- and metanotum yellow in the middle and dark all around except the tips of the wing pads, which are yellowish; abdomen transversely banded with yellow and brown. Head much wider than pronotum, especially so because of the large protruding maxillae, which are plainly visible from above; a wide, transverse, dark band bounded in front by the M-line, and in the rear by the epicranial suture; rest of head more or less yellow; hind ocelli a little closer to the eyes than to each other; antennae at least half as long as body and composed of about fifty segments; occipital ridge absent.

Pronotum almost transversely oval; less than twice as wide as long; marginal groove distinct, continuous all around, and as near the margin on the sides as in front and rear; middle field yellow, rest dark brown or blackish; meso- and metanotum yellow in the center and blackish around the border; wing pads mostly yellowish and with the outer margins about parallel with the body. Legs long and slender, mostly yellow, but usually with a dark area on the femora and with a rather thin fringe of long hairs; tarsal claws with sharp basal tooth.

Abdomen not much flattened; tergites yellow, with the basal part brown, but sometimes the posterior margin also brown; tenth tergite blackish at base. Cerci more than half as long as body; a fringe of long hairs on the dorsal line and each segment terminating in a whorl of spines; about twenty-five segments.

Gills absent.

The sexes are easily distinguished, because in the male the supra-anal process is produced beyond the tenth tergite in the form of a tubercle which may be almost as long as the tenth tergite.

The mouth parts are similar to those of *P. aestivalis*. Labrum about three times as wide as long; mandibles with five sub-equal teeth, followed by a fringe of hairs. Maxillae: cardo and stipes long, the stipes about as long as the lacinia; lacinia wide at the base and gradually narrowing toward the tip, with two long teeth, the second tooth a little more than half as long as the apical one, and, following the second tooth, only one or two hairs on the inner margin; galea about half as long as lacinia and tipped with a few hairs. Labium longer than wide; glossae short, triangular; paraglossae large, hairy; both glossae and paraglossae attenuated at the tips which are beset with papillae. Hypopharynx broadly rounded.

Described from nymphs collected at Neversink, New York, May 11, 1929. P. R. Needham.

The nymphs are quite mature and the structure of the genitalia indicates that they belong to *verticalis*.

Genus ALLOPERLA Banks

Small yellowish-brown nymphs measuring, when fully grown, 7 to 13 mm. in length. Body somewhat depressed. Head a little wider than pronotum; brownish, with the median area usually somewhat darker; three ocelli placed in an almost equilateral triangle; front ocellus smaller than hind pair, which are usually closer to the eyes than to each other; surface of head quite smooth but with feeble pilosity; sutures on head not very distinct; no occipital ridge; antennae about one-third as long as body and composed of forty to fifty segments.

Pronotum wider than long; suboval, with the angles broadly rounded; a narrow marginal groove, which in some species appears as a narrow darker line extending around the entire pronotum; surface of pronotum with long hairs, especially at the outer angles. In the mature nymphs the pronotum often shows the

darker markings of the developing imago.

Meso- and metanotum with the wing pads very wide and with the lateral margins broadly rounded; surface quite smooth, and thickly covered with brownish hairs. Legs somewhat flattened and covered with many hairs; a thin fringe of hairs is usually present on the tibiae but not on the femora; first and second tarsal segments very short, sub-equal, and the two together about onefourth as long as the third segment. Abdomen somewhat flattened. Cerci quite short, usually not much more than one-fourth the length of the body; stout at base and tapering to a slender tip; thirteen to fifteen, or possibly up to eighteen segments, which are hairy and bear on the posterior margin a whorl of long hairs.

Gills absent.

Mouth parts. Labrum very short and about four times as wide as long, clothed with long hairs; front margin with long hairs. Mandibles rather narrow; asymmetrical; left one with five more or less distinct unequal teeth; right one with six unequal teeth grouped by threes; following the teeth, on the inner margin of each mandible, a series of long stiff hairs; a second row of hairs on the ventral surface extends from the base of the teeth diagonally rearward to the inner base of the mandible. Maxillae: lacinia broad at base, gradually tapering and ending in a single incurved apical tooth, sometimes with an indication of a second short tooth; inner margin with a row of long stout hairs; galea slender, cylindric, shorter than the lacinia, and at the tip with a small bunch of hairs; maxillary palpus with the first two segments wider than long, subequal; third segment about three times as long as second; fourth segment longer than third and slightly produced on the inner apex, which bears a group of hairs; fifth segment very slender and not more than half as long as fourth. Labium. Glossae minute, triangular; paraglossae large, directed inwards at tip and covered with hairs. First segment of palpus not more than half as long as second; apical segment shorter than second and not more than half as wide. Mentum a narrow, transverse, broadly triangular band; submentum very large, wider than long, hairy. Hypopharynx rounded, closely beset with hairs, and normally extending to, or nearly to, the tip of the paraglossae.

The sexes in this genus are not readily distinguishable.

Inasmuch as the coloration of the nymphs of this genus is rather uniformly brown it is quite difficult to identify the different species. Identification of the following species has been possible only through rearing records or by adult-genitalia characters which could be detected in mature nymphs. Little is known of the biology or life cycle of the nymphs of this genus, but the life cycle appears to occupy one year.

Alloperla is generally distributed over the entire North American continent.

Key to the known Species of Alloperla

1.	Eastern forms—length up to 9 mmmediana (p. 61)
	Western forms—various lengths
2.	Length-up to 13 mm.; cerci not more than 1/4 the length of
	bodyborealis (p. 60)
	Length under 13 mm.; cerci often more than ½ the length of
	body 3
3.	Small yellowish nymphs not over 7 mm. long when fully
	grown
	Fully grown nymphs more than 7 mm. in length 4
	spatulata (p. 62)
	coloradensis (p. 60)
	lamba (p. 61)

Alloperla borealis Banks

(Plate 6, figs. 89-93; plate 17, fig. 192.)

Length of body up to 13 mm.; antennae up to 4 mm.; cerci

up to 3 mm.

This is the largest species of the genus. General color light brown with portions of head, thorax, and abdomen shaded with darker brown. Head brownish with a small lighter area in front of the anterior occllus, and with a more or less continuous transverse lighter band extending across the head from eye to eye; labrum lighter at base.

Pronotum transversely suboval; surface hairy, with long hairs on the margin; meso- and metanotum and wing pads hairy. Legs somewhat flattened and covered with short hairs, but without distinct fringe of long hairs on the outer margin of either femora or tibiae.

Abdomen hairy and quite uniformly brown. Cerci short, rather thick at the base and tapering to a slender tip; thirteen to fifteen segments. Gills absent.

The large size and the relative shortness of the cerci differentiate *borealis* from related forms. Described from mature nymphs from Temple Forks, Logan River, Utah, June 20, 1926. J. G. Needham.

Alloperla coloradensis Banks

(Plate 6, figs. 83-88.)

Length of body up to 10 mm.; antennae up to 3.5 mm.; cerci up to 3 mm.

General color yellowish brown, with the marginal groove of the

pronotum, and the meso- and metascutum, a dark brown. Head slightly wider than pronotum; eyes and ocelli black; surface smooth and sparsely clothed with hairs. Pronotum transversely suboval; front and hind margins somewhat convex; hind angles more broadly rounded than the front ones; surface somewhat rugose, with long hairs around the margin. Meso- and metanotum and wing pads covered with hairs; outer margins of wing pads broadly rounded. Legs hairy, with a sparse fringe of long, silky hairs on the outer margin of the tibiae.

Abdomen brown, hairy, the segments with a row of short stiff hairs on the posterior margin. Cerci rather short and thick at the base and tapering to a very slender tip; of about fifteen segments, each segment with a whorl of stiff hairs at the tip.

Described from mature nymphs from Boulder, Colorado, in which the genital characters could be plainly discerned.

Alloperla lamba (?) Needham and Claassen

Length of body up to 9 mm.; antennae up to 3 mm.; cerei up to 2 mm.

General color yellowish brown, with the head darker than the rest of the body.

Head a little wider than prothorax; ocelli small, hind ocelli closer to eyes than to each other; surface smooth, somewhat hairy; antennae with about forty-five segments. Pronotum half again as wide as long, suboval; hind angles more broadly rounded than front ones; marginal groove continuous all around, darker in front and rear, becoming dark brown all around in the maturer nymphs; surface hairy, with long thin hairs on the margin.

Meso- and metanotum and wing pads hairy. Legs flattened, hairy, with a fringe of hairs on the outer margin of the femora and tibiae, but thinner on the femora than on the tibiae.

Abdomen brown, hairy. In the more mature nymphs there may be seen the darker mid-dorsal line of the developing imago. Cerci with about fifteen segments.

The structure of the genitalia of the nymphs collected by the writer in Estes Park, Colorado, on Aug. 9, 1919, indicates that they very probably belong to this species.

Alloperla mediana Banks

Length of body up to 9 mm.; antennae up to 3 mm.; cerci up to 3 mm.

General color yellowish brown, with no contrasting markings

except as the adult colors are seen through the chitin of the maturing nymphs. Head smooth and feebly pilose; rest of body very hairy. Legs hairy, and tibiae with a feeble fringe of fine long hairs. Cerci with fifteen segments, the distal segments with hairs as long as the segments.

This species occurs in the Eastern States and the above description has been made from mature nymphs collected at Clinton.

New York, May 15.

Alloperla pallidula Banks

Length of body up to 7 mm.; antennae up to 2.8 mm.; cerci up to 3 mm.

General color light brown; wing pads and abdomen covered

with long hairs.

Head slightly wider than pronotum; surface smooth and sparsely clothed with hairs; eyes and ocelli black; hind ocelli much closer to eyes than to each other; antennae with about forty segments. Pronotum transversely oval, about half again as wide as long; front and hind margins straight; all angles broadly rounded; surface slightly rugose and somewhat hairy, with a few long hairs on the outer margin. Meso- and metanotum wide; wing pads broadly rounded on the sides; surface of meso-and metanotum smooth, but covered with long hairs. Legs somewhat flattened, hairy; tibiae with a thin fringe of long hairs on the outer margin.

Abdomen quite uniformly brownish, hairy; cerci with about fifteen segments, the middle segments about four times as long as wide, segments at the tip five to six times as long as wide.

Described from nymphs collected in the Big Thompson River,

Estes Park, Colorado, on August 2, 1921.

Little is known of the habits of these nymphs except that they live in swift water and that the mouth parts indicate that they are mainly carnivorous. At the time these nymphs were collected, numerous adults were also collected from the alders and willows along the Big Thompson River. Mr. Rowher informs me that he has observed the adults of this species feeding upon the honey dew which the aphids were secreting on the alders along the streams in Colorado.

Alloperla spatulata Needham and Claassen

(Plate 17, fig. 191.)

Length of body up to 11 mm.; antennae up to 4 mm.; cerei up to 2.5 mm.

General color yellowish brown; very hairy. Head yellowish with the median area darker; surface smooth and feebly pilose.

Pronotum transversely suboval and covered with long brown hair, the margin having a fringe of long hairs. Meso- and metanotum and abdomen covered with long hairs.

Legs hairy and the tibiae with a feeble fringe of long hairs. Described from mature nymphs collected in San Antonio Canyon, Claremont, California, on April 29 and May 12, 1923. J. G. Needham.

Genus CHLOROPERLA Newman

This genus is represented in North America by a single species, C. cydippe Newm. The nymphs are small, yellowish, and, when fully grown, measure not more than 6 mm. in body length. Chloroperla is very closely allied to Alloperla and identification of the nymphs is largely dependent on reared specimens.

Head a little wider than pronotum; eyes large; three ocelli; pronotum transversely oval, and much narrower than the meso-

and metanotum with the broad, rounded wing pads.

tern.

Entire body quite uniformly yellowish or yellowish brown, and sparsely clothed with hairs. The description of *C. cydippe* depicts the more detailed structures of this genus.

No study has been made of the biology of this genus, but it seems safe to state that the nymphs are found in rather swift-running water and that they are mainly carnivorous.

Chloroperla cydippe Newman

(Plate 6, figs. 94-99; plate 18, fig. 194.)

Length of body up to 6 mm.; antennae up to 2 mm. General color yellowish brown, without a contrasting color pat-

Head a little wider than pronotum; eyes large, and set considerably forward; postero-lateral angles of head broadly rounded; antennae with about thirty-five segments; three small ocelli.

Pronotum transversely oval, wider than long; all angles very broadly rounded; front and hind margins straight; marginal groove continuous all around; surface quite smooth; long hairs at the anterior and posterior angles. Wing pads broadly rounded at the tip. Legs somewhat flattened; rather sparsely clothed with hairs, and only the tibiae with a fringe of long hairs on the outer margin. Segments one and two of tarsus very short, subequal, and together hardly one-fourth as long as the third segment.

Abdomen subcylindric; posterior margin of each segment with a fringe of short stiff hairs which become more numerous with

each succeeding segment.

Mouth parts. Labrum about three times as wide as long with a fringe of hairs on the anterior margin. Mandibles nearly twice as long as wide; slightly asymmetrical; left one with five unequal teeth, the right one with four distinct teeth, and with an indication of a small fifth one; the teeth followed by a row of long hairs. Maxillae: lacinia wide at the base, a single, large, incurved terminal tooth followed by a series of long hairs. Galea cylindric. reaching almost to the tip of the lacinia, and one or more long hairs at the tip. First and second segment of maxillary palpus as wide as long, or wider, third segment a little longer than one and two together; fourth nearly half again as long as the third, and with the inner apex produced and covered with long hairs; fifth segment less than half as long as fourth, and considerably less than half as large in diameter, bearing at the tip a small tubercle and a few hairs. Labium: glossae very small, triangular; paraglossae large, with a few long hairs on the dorsal surface. First segment of palpus longer than wide, second half again as long as the first; third a little more than half as long as the second, and hardly more than half as large in diameter; the apical segment with a small tubercle, as in the maxillary palpus. Hypopharynx closely beset with short hairs at the tip.

The above description has been drawn from the cast skin of a reared nymph taken at Ithaca, N.Y. This species is common

in the Eastern States.

Genus PARAPERLA Banks

The nymphs of this genus, of which only a single species is known in western North America, are recognized by the slender body; long head with small eyes set far forward, so that the distance from the eyes to the hind border of the head is twice as great as the diameter of the eyes; a transversely oval pronotum; and absence of gills.

Color yellowish; surface of head and thorax smooth. Head slightly wider than pronotum; three small ocelli. Pronotum oval, wider than long: marginal groove continuous all around; sides and angles rounded. Legs sparsely fringed with hairs; first and second tarsal segments very short, subequal. Wing pads broad, and rounded on the lateral margins. Abdomen nearly cylindrical;

cerci short and stout.

Mouth parts are of the carnivorous type and are described under *P. frontalis*.

Paraperla frontalis Banks

(Plate 7, figs. 100-105; plate 10, figs. 167-168; plate 18, fig. 193.)

Length of body up to 18 mm.; antennae up to 7.5 mm.; cerci up to 6 mm.

This species is recognized by its slender form, absence of gills, long head with small eyes which are set far forward, a transversely oval pronotum, and broadly rounded wing pads.

General color yellowish with a little darker color around the

margin of the pronotum.

Head about as wide as long; three small ocelli placed in an equilateral triangle; eyes very small and placed far forward so as to be nearly in line with the front ocellus; occipital ridge not clearly marked; surface quite smooth; antennae with about seventy rather short segments, the apical segments not more than twice as long as wide.

Pronotum transversely oval, the sides and front and hind margins rounded; marginal groove extending all around the pronotum; surface nearly smooth; wing pads rounded on the sides and at the tip. Legs with a sparse fringe of hairs on the outer margins of femora and tibiae; first and second tarsal segments very short, subequal, third segment about four times as long as one and two combined. Abdomen nearly cylindrical; tenth tergite medially produced into a rounded lobe; cerci rather short and stout, gradually tapering toward the tip; about twenty-three segments, each segment terminating in a whorl of hairs.

Mouth parts. Labrum about four times as wide as long; the anterior margin fringed with long hairs. Mandibles slightly asymmetrical, each with four sharp teeth followed by a brush of long hairs. Maxillae; first segment of maxillary palpus about as long as wide; second segment as long as first; third segment a fourth again as long as one and two combined; fourth segment three-fourths as long as the third; and fifth a little more than half as long as the fourth, and bearing at the tip a few short hairs. Lacinia rather wide at base and ending in a large incurved tooth which bears a smaller tooth midway on the inner margin and a comb-like row of stout hairs. Below the base of the large tooth the inner margin of the lacinia is fringed with hairs. Galea rather slender, consisting of a single segment which reaches to the middle of the lacinial tooth, and which bears at the tip, a few

short spines. Labium half again as long as wide; glossae short; paraglossae very long, somewhat incurved at the tip and beset with many long hairs; hypopharynx broadly rounded, very closely beset with short hairs, and extending almost to the tips of the paraglossae; mentum broadly triangular; submentum very little wider than long, its anterior angles broadly rounded and prolonged; first segment of palpus a little longer than wide, second segment twice as long as first, and third segment almost two-thirds as long as second but less than half as wide; tip of third segment with a few hairs.

This species bears no gills.

Described from one nymph and many nymphal skins collected at Bozeman, Montana, by R. A. Cooley; and one nymphal skin from Logan River, Utah, by J. G. Needham.

Nothing is known about the biology of this species, but, judging from the structure of the mouth parts, it is undoubtedly a carnivore and probably lives in swift water.

Genus NEOPERLA Needham

This genus is readily recognized by the fact that the nymphs possess only two ocelli, which are set close together. The color in live or freshly killed specimens is a combination of yellow and brown. The gills are very long and the legs bear fringes of long delicate hairs.

Head as wide as prothorax, or slightly wider; labrum brown on anterior margin, followed by a narrow transverse yellow band which in turn is followed by a wide brown transverse band; rest of head yellow except sometimes with brown around and behind ocelli; occipital ridge very distinct; ocelli usually set very close together, the distance between them hardly more than the diameter of one occellus, although in immature nymphs they are spaced a little farther apart; antennae yellow and at least half as long as the entire body.

Labrum about four times as wide as long. Mandibles somewhat asymmetrical. Right mandible with five sharp, unequal teeth, the outer tooth the largest; following the teeth, the inner margin is fringed with long hairs. Left mandible with six unequal teeth

more or less arranged in groups of three each.

Maxillae: first segment of maxillary palpus short, and about as long as wide, second about twice as long as first, third and fourth subequal, each about as long as first and second together, fifth segment about half as long as fourth and only about half as large in diameter. Lacinia broad at base, produced into a long, sharp, incurved tooth, and with a second large tooth followed by a row of five or six stout hairs.

Labium: first segment of palpus about half again as long as wide, second nearly twice as long as first, third a little shorter than second and much more slender; glossae short and rounded; paraglossae large, broadly rounded and extending much beyond the glossae. Hypopharynx broadly rounded and beset with many short hairs.

Pronotum much wider than long; angles broadly rounded. Middle portion of pronotum yellow bordered by brown and with a narrow yellow margin. Meso- and metanotum patterned with yellow and brown; wing pads broadly rounded. Legs with a fringe of hairs on the femora and tibiae; first and second segment of tarsus very short, subequal; third segment at least four times as long as one and two together.

Abdomen slightly depressed, alternately banded with yellow

and brown. Cerci about half as long as the body.

The gills are long and much branched. There are nine pairs in the mature nymphs, located as follows: two smaller pairs at the outer base of the prothoracic legs, one large pair attached to the lateral margin of the conjunctivae, between the pro- and metasternum; two smaller pairs at the outer base of the metathoracic legs; one large pair attached to the lateral margin of the conjunctivae between the meso- and metasterna; one smaller pair at the outer base of the metathoracic legs; one large pair on the metasternum posterior to the hind legs; and one pair of caudal gills.

In the immature nymphs, not all of the above gills are found. Specimens which measure only 4 to 5 mm. in length may possess only four pairs of gills, three pairs thoracic and one pair caudal.

Neoperla clymene Newman

(Plate 7, figs. 111-116; plate 19, fig. 195.)

Length of body up to 13 mm.; antennae up to 6 mm.; cerci up to 6 mm.

General color yellowish with a brown-bordered pronotum, a bar across the anterior part of the head, and brown transverse bands on the abdominal segments.

The nymphs of this genus are at once recognized by the fact that they possess only two ocelli, which are placed very close together. The head is as wide as the pronotum, yellow, with brown over entire clypeus, the anterior margin of the labrum brown, and brown between the ocelli, extending back to the posterior margin of the head. Ocelli large, the distance between them about as great as the diameter of a single ocellus; a sharp occipital ridge extends across the entire head to the outer margin of the eyes, and bears a group of hairs at the postero-lateral angles. Antennae yellowish, of about seventy-five segments; surface of head quite smooth.

Pronotum twice as wide as long; front margin somewhat convex, hind margin very slightly concave in the center, sides convex, front angles more narrowly rounded than hind ones; middle portion of pronotum yellow, bordered by brown, and the lateral margins, as well as most of the posterior margin, yellow; surface of pronotum smooth, the margins bordered with short hairs.

Meso- and metanotum brownish with middle field and the apical half of the wing pads yellow. Legs yellow, the femora and tibiae

with a fringe of hairs.

Abdomen somewhat flattened; banded with yellow and brown, the basal half of each segment brown, and the distal half yellow; posterior margins of segments bordered by a fringe of short spinules; caudal gills about as long as tenth tergite; cerci yellow, of about forty segments, each segment terminating in a whorl of hairs.

This species was reared by Dr. C. Betten some years ago, the adult emerging on July 11. It was reared by the writer in 1927, emerging on July 3. Both specimens are from Ithaca, New York. The nymphs are found in the quieter pools in freshwater streams. They are carnivorous, and feed apparently largely upon insect larvae.

Genus CLIOPERLA Needham and Claassen

The nymphs of this genus, when fully grown, measure not much over 15 mm. in body length. The general color, as far as is known, is brown, or a combination of yellow and brown, as in *C. clio*. Head a little wider than pronotum; three ocelli, the hind ones about as close, or a little closer, to the eyes than to each other; epicranial suture distinct; occipital ridge absent; antennae about half as long as the body.

Pronotum transversely oval; about twice as wide as long; marginal groove distinct in front and rear, but indistinct on the sides. Wing pads well developed and elongated; front wing pads lying almost parallel to the body, and sinuous on the lateral margins; hind wing pads directed slightly outward. Legs rather

slender; not much flattened; a thin fringe of long hairs on the outer margin; first and second tarsal segments very short; tarsal claws each with a small basal tooth. Abdomen not much flattened; cerci at least half as long as the body. Gills absent.

The mouth parts probably serve as the most reliable characters for identification of this genus. The detailed description of the

mouth parts of C. clio applies to all three known species.

This genus is rather closely allied to Isoperla and the gill-less species of Perla. The shape of the lacinia and the slender pointed apical segments of the maxillary and labial palpi, are especially helpful in the identification of the nymphs of Clioperla.

Little is known of the biology of the nymphs but the structure of the mouth parts indicates that they are carnivorous. *C. similis* occurs in small upland spring brooks, and the general shape of the nymphs of this and the other two known species leads me to believe that they do not inhabit the swifter parts of the larger streams, but are restricted to smaller brooks.

Key to the Species of Clioperla

Clioperla clio Newman

(Plate 7, figs. 106-110; plate 19, fig. 196.)

Length of body up to 15 mm.; antennae up to 7 mm.; cerci up to 8 mm.

General color yellow and brown; head with a wavy brown transverse band; pronotum yellow in center with brown all around; sides of pronotal disc yellow; abdominal tergites brown with a more or less distinct middle transverse band of yellow.

Head a little wider than pronotum, maxillae projecting outward somewhat, so as to be visible from above; a dark wavy transverse band passes over the front ocellus with arms directed backward to the hind ocelli, thus leaving an inverted V-shaped or rounded yellow spot between the hind ocelli; in more fully

patterned nymphs the clypeal area is brownish, also with some brown on the occiput; hind ocelli a little closer to the eyes than to each other; occipital ridge absent; antennae about half as long

as body and composed of about forty-eight segments.

Pronotum transversely oval, and about twice as wide as long; marginal groove distinct in front and rear; sides somewhat flanged and yellow; central area yellow, but completely surrounded by brown; margin fringed with short spinules and a few longer hairs. Meso- and metanotum mottled with yellow and brown. Legs slender, yellow, with a fringe of long hairs.

Abdomen nearly cylindrical; tergites brown except for a median yellow transverse band. Cerci more than half as long as the body and composed of about thirty segments, each segment terminating in a whorl of short spinules. Subanal lobes rather long

and attenuated at the tip.

The sexes are not easily recognized. In the female, the posterior margin of the eighth abdominal sternite shows a slight emargination in the center, and there are no spinules in this area. In the male, the posterior margin of the eighth abdominal sternite is either straight or slightly produced in the middle, and the row of marginal spinules is continuous; the ninth sternite is slightly more produced posteriorly in the male than in the female. In mature nymphs the details of the genitalia can often be clearly seen.

Mouth parts. Labrum more than three times as wide as long; anterior margin with a fringe of long hairs. Mandibles with six unequal teeth arranged in two groups of three each; following the teeth is a fringe of long hairs. Maxillae: cardo and stipes about equally long; lacinia very wide at the base, and equally wide up to the base of the teeth; bidentate, the second tooth a little more than half as long as the terminal one; margin beyond teeth with a fringe of long stout hairs, also a couple of hairs between the teeth; galea about half as long as lacinia and tipped with a seta; maxillary palpus long, slender, and with the terminal segment much attentuated. Labium about as wide as long; glossae small; paraglossae large, hairy, somewhat attentuated, and with a few papillae at the tip; palpi long and slender, the apical segment as slender as the apical segment of the maxillary palpus. Hypopharynx broadly rounded.

Many nymphs from Elkhart, Indiana, April to May (R. Weith), and reared specimens from Work's Brook, Ottawa, Il-

linois, April 3, 1902.

Clioperla ebria Hay

Length of body up to 16 mm.; antennae up to 8 mm.; cerci up to 9 mm.

General color yellowish brown to darker brown. Head a little wider than pronotum; maxillae barely visible from above; a yellow mark between the hind ocelli, one in front of the anterior ocellus and one each side of the occiput just inside of the eyes; occipital ridge absent; hind ocelli a little closer to the eyes than to each other; antennae about half as long as the body, and made up of about seventy segments.

Pronotum transversely oval; about twice as wide as long; margin with a fringe of short hairs; marginal groove distinct in front and rear but indistinct on the sides, which are somewhat flanged and light yellow. Front wing pads long, widely separated, and lying almost parallel with the body; hind wing pads diverging outward from body. Legs slender, not much flattened, and with a very feeble fringe of long hairs. Cerci composed of about thirty-two segments, the terminal segments about five times as long as wide.

Described from three mature male nymphs collected by G. S. Dodds in Tolland, Colorado, and one female nymph without locality label.

Clioperla similis Hagen

Length of body up to 10 mm.; antennae 5 mm.

Color yellowish brown.

Head slightly wider than pronotum; hind ocelli about as close to the eyes as to each other; occipital ridge absent; antennae about half as long as the body and composed of about fifty-five segments.

Pronotum transversely oval; about twice as wide as long; marginal groove distinct in front and rear but indistinct on the sides. Wing pads well developed and very similar to those of C, clio.

Legs slender, with a thin fringe of long hairs.

Mouth parts very similar in structure to those of C. clio.

Described from a single reared male nymphal skin from Ringwood, Ithaca, New York, April 17, 1922. P. W. Claassen.

Genus ISOPERLA Banks

This genus includes nymphs which, when fully grown, do not measure much over 10 mm. in body length.

General color yellow and brown, often longitudinally striped.

Head about as wide as, or a little wider than, pronotum; three distinct ocelli placed in an almost equilateral triangle; antennae long and slender with from forty-five to fifty segments; occipital ridge absent.

Pronotum about half again as wide as long; all angles broadly rounded, the hind angles more so than the front ones; marginal

groove more or less continuous around entire pronotum.

Meso- and metanotum, including wing pads, yellow, and streaked with brownish markings; legs somewhat depressed, quite uniformly brownish, hairy; tibiae with a fringe of long hairs on the outer margin; first two segments of the tarsus very short, subequal, and together not more than a third as long as the third segment; claws large, with a small basal tooth.

Abdomen somewhat depressed; cerci composed of about thirty

segments.

Mouth parts. Labrum three to four times as wide as long; front margin nearly straight, and fringed with long hairs; upper surface hairy; ventral surface on each side with long curved hairs directed inward. Mandibles somewhat asymmetrical; each with six teeth arranged in groups of three, the teeth followed by a series of hairs. Maxillae: lacinia large, broad at the base, bidentate; the second tooth more than half as long as the apical one; inner margin of the lacinia slightly concave in the center and with a series of long hairs. Galea cylindric, reaching to the base of the lacinial teeth and bearing a few hairs at the apex. Maxillary palpus with segments one to four progressively longer, and the terminal segment about two-thirds as long as the fourth. Labrum large; glossae small, triangular; paraglossae large, directed inward, hairy, with long thin hairs on the margins; tips of glossae and paraglossae with small sensory buds. Hypopharynx large, rounded, normally produced to the end of the paraglossae and with a spinulose area at the tip.

The nymphs of this genus are common in most of the freshwater streams. They are carnivorous, but in their younger stages one sometimes finds plant remains, such as diatoms and algae, in their digestive tract.

Isoperla is distributed over the entire United States, and is of considerable importance as food for trout and other fish.

Key to the Species of Isoperla

	stripes
 	 bilineata (p. 73)
	2

2.	Caudal half of abdominal segments dark, and the basal half
	yellowsignata (p. 75)
	Abdomen with a wide, median, longitudinal yellow stripe. 3
3.	Wing pads well developed; legs with fringes of long hairs
	5-punctata (p. 74)
	Wing pads absent, i.e. the postero-lateral angles not pro-
	duced; legs without prominent hair fringes

Isoperla bilineata Say

(Plate 8, figs. 123-128.)

Length of body up to 10 mm.; antennae up to 5.5 mm.; cerci up to 5.5 mm.

General color yellowish with dark brown markings. Easily recognized by three longitudinal dark stripes on the dorsum of the abdomen and by the color pattern of head and thorax.

Head very little wider than pronotum, yellowish with dark brown to blackish markings varying somewhat in different individuals. In the lighter specimens there is a wide, irregular, transverse, dark bar across the center of the head, extending from the base of one antenna to the other. In addition to this bar, there are darker markings in front of the elypeus, and dark blotches behind the posterior ocelli and back of the eyes. In the darker specimens, the entire head is almost uniformly brown except for a yellow spot in the ocellar triangle, another in front of the anterior ocellus, and a narrow one behind the ocellar triangle. The three ocelli are placed in an almost equilateral triangle, the hind ones being a little closer to the eyes than to each other; surface of head smooth and rather sparsely clothed with brown hairs; antennae composed of about forty segments.

Pronotum about twice as wide as long; suboval; hind angles more broadly rounded than front ones. A wide, median, longitudinal yellow stripe; disc brownish; lateral margins yellow; marginal groove distinct along the anterior and posterior margins but indistinct on the lateral margins; surface nearly smooth and moderately covered with short brown hairs.

Meso- and metanotum and wing pads yellowish with many irregular dark markings. Legs somewhat flattened, hairy, the femora and tibiae with a fringe of thin long hairs, more pronounced on the femora than on the tibiae.

Abdomen yellowish, with three wide, dorsal, longitudinal dark stripes and in some specimens also with darker interrupted markings on the sides of the abdomen; surface hairy; posterior margin of each segment with a row of short spinules. Cerci brownish; about twenty-five segments, each of which ends in a whorl of short spinules and with longer hairs on the dorsal surface.

This is one of the most common stoneflies in the Central and Eastern States.

Ithaca, N.Y.; North Lansing, Mich.

Isoperla 5-punctata Banks

Length of body up to 12 mm.; antennae up to 7 mm.; cerci up to 6 mm.

General color yellow with brown markings; easily recognized by the wide median yellow stripe running the entire length of the abdomen and a broad brown stripe on each side.

Head a little wider than pronotum; brown, with a few lighter spots in front of the ocellar triangle, and a large yellow irregular spot between the eyes; surface smooth, with a rather sparse coating of short brown hairs; antennae with about fifty segments.

Pronotum approximately half again as wide as long, more or less uniformly brown except for a wide median longitudinal yellow line, and the yellow lateral margins; angles rounded, the posterior ones more so than the anterior ones; surface nearly smooth and covered with brown hairs which are longer on the outer margin than on the surface.

Meso- and metanotum yellowish with longitudinal darker markings, especially noticeable on the wing pads. Legs uniformly

brownish, bearing a fringe of long hairs.

Abdomen with a broad median longitudinal yellow band, on either side of which there is a longitudinal brown band. Sides and ventral surface of abdomen more or less uniformly yellowish brown; cerci composed of about twenty-eight segments.

This species was described from a nymphal skin of a female which was reared by Miss Robinson, at San Jose Creek, near Pomona, California, March 20, 1923. I have, also, nymphs from San Antonio Canyon, California, May 12, 1923; Logan River, Utah, June 23, 1926, J. G. Needham; Santa Fe, New Mexico, June 1, 1904, P. B. Powell.

Isoperla petersoni Claassen

(Plate 20, fig. 197.)

Length of body up to 9 mm.; antennae up to 4.5 mm.; cerci up to 4.5 mm.

General color brown with a wide, yellow median longitudinal stripe running the length of the thorax and abdomen, and with a narrow yellow stripe on each side of the abdomen.

Head about as wide as pronotum; a yellow spot in front of the anterior occllus, and a yellow area inside the eyes, extending from the base of the antennae to the hind margin of the head.

Pronotum with a wide median yellow longitudinal stripe; a yellow spot on each lateral field, and the lateral margins also yellow. Meso- and metanotum similar in coloration to pronotum, and, since the adult is apterous, or very nearly so, the postero-lateral angles are not prolonged.

Legs slender and without a fringe of long hairs.

Abdomen marked with three longitudinal stripes as noted above.

The nymphs of this species were collected by J. G. Needham at Peterson's Springs, Logan, Utah, July 26, 1926.

Isoperla signata Banks

(Plate 20, fig. 198.)

Length of body up to 10 mm.; antennae up to 5.5 mm.; cerci up to 5.5 mm.

Color yellow with brown markings. Recognized by two dark, transverse bands across the head; pronotum margined with brown; abdominal segments with the basal half yellow and the caudal half brown.

Head not wider than pronotum; yellow with brown markings as follows; a broad transverse band just back of the yellow labrum; this band connects at the outer margins with another wavy band extending across the head in line with the front ocellus, and in the middle extending caudad over the ocellar triangle, leaving a yellow spot in the center of the ocellar triangle. In some specimens the occiput is somewhat darker; hind ocelli a little closer to the eyes than to each other; antennae composed of about forty-eight segments.

Pronotum suboval, in some specimens almost rectangular; half again as wide as long; angles rounded; the large middle yellow area bordered with brown but with the lateral margins also yellow. Meso- and metanotum yellow with brown markings on the anterior and posterior margins, and with two longitudinal brown stripes on the front wing pads. Legs yellow with a fringe of long hairs on the outer margin, most pronounced on the tibiae.

Abdominal segments one to nine each with the basal half yel-

low and the caudal half brown; last segment yellow except for a small, basal, median brown spot; surface hairy, each segment with a fringe of short hairs on the posterior margin. Cerci yellow, of about twenty-two segments, each segment ending in a whorl of short hairs.

Described from reared specimens, May 19 to 31, 1926, Ithaca, N.Y.

Genus PERLESTA Banks

The nymphs of this genus resemble the nymphs of Perla but the segments of the cerci are longer in Perlesta than in Perla. The body is generally covered with small brown spots, giving the

nymphs a freckled appearance.

Length of the full-grown nymphs is about 10 mm.; color yellowish to yellowish brown, usually with a darker transverse band between the eyes, crossing the ocellar triangle; head a little narrower than pronotum; eyes moderately large; three ocelli arranged in an isosceles triangle with the hind ocelli closer to each other than to the eyes; occipital ridge noticeable, although not as prominent as in most of the species of Perla. Antennae of medium length and composed of approximately fifty segments. Pronotum transversely oval, sides broadly rounded; surface quite smooth and lateral margins somewhat produced in the form of flattened flanges; meso- and metanotum large, wing pads broad. Abdomen somewhat flattened, posterior margins of segments fringed with medium-sized spinules. Legs flattened, hairy, with long fringes of hairs on the outer margin of the femora and tibiae; first and second tarsal segments short, subequal, and together less than half as long as the third; cerci very long, about four-fifths as long as body with the segments beyond the middle four to five times as long as wide; each segment terminating in a whorl of long hairs.

Seven pairs or groups of branched filamentous gills. Entire surface of body covered with long hairs, more noticeable in the

younger specimens than in the fully mature ones.

Mouth parts. Labrum about four times as wide as long, the anterior margin fringed with hairs. Mandibles asymmetrical, each with five sharp teeth followed by a series of long hairs. Maxillae rather long and slender; lacinia unique in that the inner margin below the large terminal tooth is devoid of a series of hairs, except for one long hair at the base of the second tooth, which is very long; galea very slender, extending about to the middle of the terminal tooth; tip of galea bearing a small bunch of hairs;

maxillary palpus long and slender reaching far beyond the tip of the lacinia; the terminal segment tapers to a rather fine point; stipes about as long as lacinia. Labium wide; submentum about twice as wide as long; glossae short, triangular; paraglossae large and rounded at the tip; both glossae and paraglossae with a few tubercles at the tip.

Perlesta placida Hagen

(Plate 4, figs. 60-65; Plate 21, fig. 199.)

Length of body up to 10 mm.; antennae up to 5 mm.; cerci up to 6 mm.

General color yellowish brown, with a tendency toward having the entire body covered with small brown dots, giving it a freekled appearance. Head a little narrower than the pronotum, yellowish with a darker transverse band across the head through the region of the ocellar triangle; hind ocelli closer to each other than to the eyes; occipital ridge not very prominent but plainly indicated by a series of very short hairs, and by brown markings; antennae long and slender and composed of at least fifty segments.

Pronotum at least twice as wide as long; front margin convex, hind margin nearly straight; angles broadly rounded; surface slightly rugose, yellowish brown with lighter areas on the lateral margins and along the middle of the anterior and posterior margins; a shallow groove extends around entire pronotum; sides of pronotum with rather wide flanges; surface quite hairy, with rather long hairs all around the margin; meso- and metanotum very broad, sides usually much rounded.

Legs flattened; femora and tibiae fringed with long hairs; first and second tarsal segments short, subequal, the two together less than half as long as third segment. Abdomen depressed; surface hairy; posterior margin of each segment with a row of spinules. Cerci long and slender and composed of about twenty-

five segments, the ones beyond the middle very long.

Seven pairs of branched gills; two pairs on the prothorax at the outer base of the legs; two double pairs on the mesothorax, the first at the antero-lateral margin of the mesosternum, the other at the outer base of the legs; two pairs on the metathorax, the first at the antero-lateral margin of metasternum, the other at the outer base of the legs. One pair of anal gills.

The nymphs are carnivorous and occur mostly in swift water. This species is widely distributed over the Central and Eastern

States.

Ithaca, N.Y.; Elkhart, Ind.; Lake Forest, Ill.; W. Ottawa, Ill.; Potomac R., Brunswick, Md.

Genus ATOPERLA Banks

Length of body not over 12 mm. The nymphs of this genus possess copious thoracic gills but no anal gills. The lacinia of the maxilla terminates in a single tooth; posterior ocelli distinct, and anterior ocellus either entirely absent or indicated by a small depression.

In general appearance Atoperla is similar to Perlinella but is

smaller in size and has no anal gills.

Atoperla ephyre Newman

(Plate 8, figs. 129-134; plate 22, fig. 200.)

Length of body up to 9 mm.; antennae up to 3 mm.; cerci up to 3 mm.

These small brownish nymphs possess long gill tufts on the thorax, have only two distinct ocelli, set much farther apart than in *Neoperla*, and have the lacinia unidentate.

The specimens which I have are old and shriveled, hence there is some question whether the rather uniform brownish color repre-

sents the true color of fresh specimens.

Head slightly wider than pronotum; hind margin of eyes in line with posterior ocelli, which are as close to the eyes as to each other; front ocellus either absent or only indicated by a small depression; occipital ridge absent.

Pronotum nearly twice as wide as long; hind angles very broadly rounded, front ones more narrowly rounded; marginal groove continuous all around; surface only slightly rugose. Wing pads considerably prolonged; broadly rounded at the tips.

Legs flattened; femora and tibiae with a fringe of long hairs; first and second tarsal segments very short, subequal; third segment about four times as long as the two preceding combined.

Abdomen brownish, slightly depressed. Cerci of about twenty-five segments. Labrum about three times as wide as long, with a fringe of hairs on the front margin. Mandibles rather narrow, asymmetrical; each with four rather large teeth followed by a fringe of hairs. Maxillae: lacinia unidentate; inner margin with six or seven very stout hairs, the one next to the apical tooth so large as to suggest a second denticle. Galea slender and shorter than lacinia. Labium; glossae very short, triangular; paraglossae large and widened toward the tip.

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Three alcoholic specimens from Fox River, Ottawa, Illinois, May 31, collected by W. A. Howard.

Genus PERLINELLA Banks

This genus, of which only one species, *P. drymo* Newman, is known from North America, is readily recognized by its almost uniformly yellowish brown color; its long head with small eyes set far forward on the head so as to be located on a line almost even with the front ocellus; its long, branched, copious gills on the thorax; and a pair of small caudal gills. The mature nymphs are medium sized, measuring less than an inch in length when fully grown. Antennae and cerci each almost half as long as the body; three ocelli, the anterior one small.

Pronotum transversely oval; wing pads wide, rather broadly rounded on the sides and at the apex. Legs fringed with long hairs. First two segments of tarsus very short, the third one about four times as long as one and two combined.

Abdomen slightly flattened; tenth tergite produced into a median rounded lobe; cerci long and slender with the apical segments very long.

Generally distributed east of the Mississippi River.

Perlinella drymo Newman

(Plate 8, figs. 117-122; plate 22, fig. 201; plate 32, fig. 225.)

Length of body up to 22 mm.; antennae up to 10.5 mm.; cerci up to 12 mm.

Yellowish brown. Readily recognized by its long head, small eyes set far forward, and by its much-branched, copious, long tracheal gills. Head almost as long as wide, slightly wider than pronotum; yellowish with an irregular transverse dark band, and with darker areas on the clypeus and occiput; ocelli small, placed in an equilateral triangle; eyes small, set forward in the head so as to be nearly in line with the front ocellus; antennae yellow, long and slender.

Pronotum transversely oval, about half again as wide as long, almost uniformly brownish, with a dark narrow marginal groove; surface nearly smooth; sides and angles broadly rounded. Meso-and metanotum irregularly marked with brown and yellow; wing pads broadly rounded on the sides and with tips broadly rounded. Legs-fringed with long hairs; first and second tarsal segments very short, subequal, the third about four times as long as one and two together.

Abdomen depressed, quite uniformly yellowish brown; cerci long and slender, and composed of about forty segments, each

segment tipped with a whorl of spines or hairs.

The gills of this species are longer in proportion to the size of the body and more copious than in any other known nymphs. They are located as follows; two pairs at the outer base of the front legs; one pair, each consisting of two main trunks, on the lateral margin of the conjunctivae between the pro- and mesothorax; two pairs at the outer base of the lateral margin of the conjunctivae between the meso- and metathoracic legs; one pair, each with three main trunks, at the postero-lateral base of the metathoracic legs, and one pair of small caudal gills attached to the subanal lobes. In the more immature forms, the caudal gills are either absent, or so small as to be easily overlooked.

Mouth parts. Labrum about four times as wide as long. Mandibles slightly asymmetrical, each with four teeth followed by long hairs. Maxillae: first segment of palpus about as wide as long; second half again as long as wide; third and fourth subequal, each about as long as one and two combined; fifth about three-fourths as long as fourth, and half as wide. Galea slender, two-segmented, the basal segment a little longer than the apical one, which is tipped with a few hairs. Lacinia broad at base and gradually tapering to a long incurved tooth, which has at its base a second long tooth; this second tooth is followed by a series of about six long stout hairs and a series of more slender hairs. Labium: first segment of palpus twice as long as wide, the second half again as long as first, third about as long as first but much more slender; glossae small; paraglossae produced into large rounded lobes.

Little is known about the biology of this species. The nymphs occur in pools of streams and have been taken several times from Beebe Lake, a small lake formed by an artificial dam in Fall Creek, Ithaca, New York. Specimens have been reared as follows: Elkhart, Indiana, April 2, by A. Weith; Lake Forest, Illinois, April 15, 1902, by J. G. Needham.

Genus ACRONEURIA Pictet

The nymphs of this genus are rather large, mostly more than an inch in length when fully grown. Body depressed; gills under thorax, and some species with anal gills also. Color varying from uniform brown to strikingly colored patterns of yellow and brown.

In general appearance these nymphs resemble very closely the

nymphs of Perla (sens. str.) but in most of the known Acroneuria nymphs, the occipital ridge is absent (except in ruralis and depressa). In many specimens it is often possible to observe the venation in the wing pads, and this, together with a study of the genital structures of mature nymphs, aids in placing the specimens in the correct genus.

Head rather wide and short; three ocelli; antennae long and

slender.

Pronotum much wider than long; rounded; marginal groove more distinct in front and rear than on sides. Wing pads wide and not much produced. Legs with a wide fringe of hairs on the outer margin; first and second tarsal segments very short and subequal.

Abdomen depressed; the sexes not easily recognized except in mature nymphs where the developing genital characters may be observed. Cerci long and slender.

Mouth parts very similar to those of the nymphs of Perla.

So far as is known the nymphs inhabit swift-water streams where they occur underneath the stones. The life cycle extends, apparently, over three years in most, if not all, species. This genus ranges over the entire United States and Canada.

Key to the Nymphs of Acroneuria

· -
1. Anal gills present
Anal gills absent 5
2. A distinct occipital ridge presentdepressa (p. 86)
Occipital ridge absent 3
3. Western; anal gills very copious; head with a pronounced
blaze, i.e. a yellow mark extending from the labrum to the
anterior ocellus; pronotum without pronounced yellow
lateral flangespacifica (p. 88)
Eastern or Southern; anal gills of rather few filaments; head
without a blaze; a dark transverse band extends across the
entire head in front of the anterior ocellus; pronotum with
wide yellow flanges on the side 4
4. Last abdominal tergite uniformly brownarida
Last abdominal tergite darker on the posterior margin; espe-
cially noticeable in the middle prolongation arenosa (p. 84)
5. A distinct occipital ridge present; cerci longer than body;
color uniformly brown
No distinct occipital ridge; cerci shorter than body; body
with striking color patterns 6

6. Abdominal tergites with basal half yellow and caudal half
dark (even in the darkest colored nymphs the last ab-
dominal tergite has a yellow basal spot with the caudal
half black); Easternlycorias (p. 87)
Abdominal tergites not distinctly banded with yellow and
dark; and never with the hind margin of the abdominal
tergite blackish
7. Eastern; abdomen uniformly dark brown or blackish; femora
with a longitudinal dark band on the upper surface
abnormis (p. 82)
Western; mostly yellowish 8
8. A yellow spot over the ocellar triangle; head and thorax very
strikingly patterned
Ocellar triangle dark; head and thorax not strikingly pat-
terned theodora (p. 90)

Acroneuria abnormis Newman

(Plate 5, figs. 66-70; plate 31, fig. 221.)

Length of body up to 29 mm.; antennae up to 16 mm.; cerci

up to 22 mm.

The nymphs of this species normally are dark brown to blackish in color, with lighter markings on the head, pro-, meso-, and metanotum, but with the abdomen usually uniformly brown, and with the last abdominal segment dark brown or blackish; the cerci are usually as long as, or slightly longer than, the body and possess long hairs on the inside, especially near the base. The legs bear thick fringes of very long hairs.

Head slightly wider than pronotum, dark brown to blackish; occiput yellow; a yellow spot outside of hind ocelli; a yellow M-line, which in some specimens is more interrupted; clypeus yellow; labrum dark brown; hind ocelli about half again as close to each other as to the eyes; area behind eyes with short spines on the caudo-lateral angles; surface smooth; antennae with about

ninety segments.

Pronotum a little less than twice as wide as long; front margin broadly convex; hind margin nearly straight; sides rounded; angles broadly rounded; surface brown to blackish, with yellow markings, as indicated in Plate 31, fig. 221. Lateral margins also lighter; marginal groove extends completely around pronotum, but is narrower and deeper on the anterior and posterior margins than on the sides; meso- and metanotum dark brown, with yellow markings.

Legs broad and much flattened; femora covered with fine hairs, interspersed with stout spines; along their middle a narrow, longitudinal line, in which the hairs are absent; the entire leg bears a thick fringe of long hairs on the outer margin.

Abdomen somewhat flattened and usually uniformly brown or blackish in color, although in some of the lighter specimens there is a tendency for a yellowish spot to appear on the posterior half of each segment along the median dorsal line; the abdominal segments are all bordered posteriorly with a fringe of short spines; on the tenth tergite these are a little longer. Cerci very long and on the inside with a thick, wide fringe of long hairs, especially copious at the base, gradually becoming shorter and thinner toward the tip, and extending the entire length of the cerci; the individual segments, of which there are about sixty, each bearing a whorl of spines on the posterior margin.

Eight pairs of branched, tracheal gills as follows: two pairs at the outer base of the prothoracic legs; one pair each on the outer conjunctivae between the pro- and mesothorax, and between the meso- and metathorax; two pairs at the outer base of the mesothoracic legs; one pair at the outer base of the metathoracic legs, and one double pair at the caudal base of the metathoracic

legs; anal gills absent.

Mouth parts. Labrum about three times as wide as long; blackish, the front margin having a fringe of long hairs. Mandibles somewhat asymmetrical, each with five distinct, sharp teeth, of which the first, second, and fourth are the largest; following these teeth is a fringe of long, stout hairs. Maxillae with lacinia bidentate, with a series of long, stout hairs; galea distinctly twosegmented, cylindrical, slender, shorter than the lacinia, and with a small bunch of hairs at the apex; maxillary palpus five-segmented, first about as long as wide, second a little more than twice as long as wide, the apical segment only about half as long as the fourth, and much more slender. Labium very broad; submentum much broader than long; glossae short, more or less triangular; paraglossae large with long hairs on the inner margin; the threesegmented labial palpus extends beyond the paraglossae; the first segment about twice, or a little more than twice, as long as wide; second about a third again as long as first, the third about two-thirds as long as the second, and much more slender. Hypopharynx rounded and normally extending nearly to the tip of the glossae.

This species is common in the larger swift-water streams of the Eastern States. The long thick fringes on the legs and the copious fringes of hairs on the inner side of the cerci, in which considerable silt and dirt collect, gives the nymphs a rather unique appearance and is an aid in identifying them in the field. The nymphs are, of course, carnivorous in habit, and they apparently have a three-year life cycle. In some of the specimens which have been collected around Ithaca, I have found on the wing pads, and on the legs, small Chironomidae larvae. Whether these larvae are parasitic upon the nymph has not been definitely established, but it appears that this is not a mere accidental association, and that possibly these larvae may, to some extent, at least, be parasitic upon the stonefly nymphs.

Ithaca, N.Y.; Moffitsville, N.Y.; Potomac R., near Harper's

Ferry, Md.

Acroneuria arenosa Pictet

Length of body up to 24 mm.; antennae up to 15 mm.; cerci

up to 24 mm.

This genus is represented in our collection by a single specimen, collected from the Potomac River at Great Falls, Virginia, April 10, 1926. Identification was made possible by a study of the venation of the wing pads, which were far enough developed to clearly indicate the peculiarly much-branched condition of the anal veins of the front wings, a condition unique to this species.

Nymphs rather strikingly patterned with yellow and brown. Head a little narrower than pronotum, the area posterior to the epicranial suture mostly yellow, with the portions behind the eyes darker brown; clypeus, frontal M-line, and a spot on the outside of each hind ocellus, yellow, remainder dark brown. Hind ocelli nearly twice as close to each other as to the eyes. Antennae vellowish, with about one hundred segments.

Pronotum nearly twice as wide as long, discs and lateral margins yellow, the rest dark brown; front margin fairly convex; hind margin slightly concave in center; angles broadly rounded; surface nearly smooth and covered with a fine coating of hair. Meso- and metanotum patterned with yellow and brown, outer portions of wing pads brown, inner portions yellowish.

Legs quite uniformly yellowish, with a median, longitudinal, narrow smooth line on the dorsal surface of the femora; margins

of legs with a thick fringe of whitish hairs.

Abdominal segments brownish, with a row of roundish, yellow spots along the median dorsal line, and with similar spots on the lateral margin of the posterior segments. Posterior margin of last abdominal tergite dark brown or blackish. In this respect it resembles *lycorias* somewhat, but this dark band is narrower in *arenosa*. Cerci yellowish, with a rather thin fringe of hair on the inner margin; composed of about sixty segments, each segment terminating in a whorl of short spines.

Gills very similar in size and location to those of abnormis, however, arenosa possesses a pair of small caudal gills in addition

to the thoracic ones.

Nothing is known of the life history of this species, although the mouthparts indicate that it is carnivorous in habits, and the general structure suggests that it normally inhabits the larger swift-water streams.

Potomac River at Great Falls, Va.

Acroneuria californica Banks

(Plate 26, fig. 205.)

Length of body up to 24 mm.; antennae up to 10.5 mm.; cerci

up to 14 mm.

General color yellow and brown; entire body thickly covered with short brown hair. The yellow spot over the ocellar triangle serves as a good identification mark of this species. This yellow spot is bounded on the rear by the arms of the epicranial suture, extends laterally beyond the hind ocelli to a sharp point, and reaches anteriorly almost to the front ocellus. Hind ocelli much closer to each other than to the eyes; occipital ridge faintly indicated by a row of spinules, especially in the center of the occiput. Entire surface of head thickly covered with short brown hair, usually more noticeable on the darker areas; antennae nearly half as long as body and made up of about eighty segments.

Pronotum a little narrower than head, slightly widened posteriorly; front and hind margins convex; hind angles more broadly rounded than front ones; marginal groove distinct; lateral flanges narrow and yellow; median longitudinal yellow line narrow. Meso- and metanotum and wing pads covered with hairs, and on

the outer margins with short spinules.

Legs flattened; with a fringe of long hairs on the outer margin. Abdomen not much flattened, yellowish but with the posterior margins of the tergites brown, covered with brown hairs and the posterior margins of the tergites with a fringe of spinules. Cerci about half as long as the body and composed of about thirty-five segments, each segment ending in a whorl of spines.

Nine pairs of gill tufts; two pairs at the outer base of the prothoracic legs; two pairs in similar locations on the meso-

thoracic legs; three pairs at the postero-lateral base of the metathoracic legs; one pair on the lateral conjunctivae between the pro- and mesosternum, and one pair in a similar location between the meso- and metasternum. Anal gills absent. In the male nymphs the ninth sternite is somewhat produced, and in mature nymphs the elongate "hammer" is noticeable. The female nymphs are larger than the males, the ninth abdominal tergite is not much produced and the developing genital opening is plainly indicated in the middle of the posterior margin of the eighth sternite.

Mouth parts of the carnivorous type and very similar in structure to the mouth parts of other species in this genus.

This species has not been reared, but I have before me a number of mature nymphs in which the genitalia can be clearly seen, and this has made possible the identification.

Nothing is known of the life history or biology of this species, but the life cycle probably is not completed in less than three years.

Eel R., Calif.; Evey's Canyon, Calif.; San Jacinto, Calif.; San Antonio Canyon, Claremont, Calif.; Logan R., Utah.

Acroneuria depressa (?) Needham and Claassen

(Plate 27, fig. 207.)

Length of body up to 31 mm.; antennae up to 15 mm.; cerei up to 20 (?) mm.

Head about as wide as pronotum; ocelli very large, hind ones closer to each other than to the eyes; between the transverse dark band, which passes through the ocellar triangle, and the lateral arms of the epicranial suture, there are three inverted V-shaped yellow spots; one between the ocelli and one outside of each hind ocellus; occipital ridge strongly developed and uniformly prominent across the occiput; antennae about half as long as body and made up of about eighty to eighty-five segments; surface of head with many short brown hairs.

Pronotum about twice as wide as long; hind angles very broadly rounded, front ones more narrowly so; lateral discs yellow with brown markings; marginal groove distinct and continuous; entire margin of pronotum dark brown around the edge.

Meso- and metanotum with a variegated pattern of yellow and brown, covered with short brown hairs, and the outer fields of the wing pads with short spinules. Legs flattened; yellowish with a transverse brown band across the middle of the femora, and the proximal end of tibiae brown; outer margin with a fringe of

long hairs.

Abdomen flattened; basal half of tergites usually darker brown than caudal half; tenth tergite usually brown except for a small oblong yellow spot in the center; surface covered with brown hairs; each segment with a fringe of short spinules; cerci more than half as long as body and made up of forty or more segments (tips broken off).

Gill tufts as in A. californica, except that this species has, in addition to the thoracic gills, a pair of large anal gill tufts.

The mouth parts are very similar in structure to those of A.

californica.

The above description is made from four specimens; two immature nymphs and a cast skin from Left Branch, Provo River, Logan, Utah, July 28, 1926, J. G. Needham; and one almost mature nymph which bears the label Nez Perces Cr., above Basin, Rocky "ripples," Aug. 15, '90, 26913.

It was at first thought that these nymphs might belong to the genus Perla, because of the distinct occipital ridge, but the large ocelli, the general structure, and the faint indication of a "hammer" on the ninth abdominal sternite of the male nymphs indicate that they very probably are the nymphs of A. depressa.

Acroneuria lycorias Newman

(Plate 10, figs. 165-166; plate 31, fig. 222.)

Length of body up to 24 mm.; antennae up to 15 mm.; cerci up to 18 mm.

The nymphs of this species are strikingly marked with brown

and yellow.

Head a little narrower than the pronotum; transversely banded with yellow and dark brown. Entire occiput behind the epicranial suture yellow, except for a small area behind the compound eyes; area in front of the epicranial suture up to the region of the fronto-clypeal suture dark brown, except for the transverse Mmark and a small yellowish mark on the outside of the posterior occili. Clypeus yellow; labrum dark brown; hind occili about twice as close to each other as to the eyes. Antennae yellowish, of about one hundred and five segments.

Pronotum nearly twice as wide as long, slightly widened posteriorly, front margin somewhat convex, hind margin nearly straight; all angles broadly rounded.

Legs much flattened; coxa, trochanter, and the basal part of

femur, brown, and the femora with another transverse brown

band just before the apex.

Abdominal segments normally with their basal half yellowish, and the posterior half dark brown to blackish. In some of the more darkly colored specimens the segments are almost entirely brown or blackish, with only the median portion of the basal parts yellowish. Cerci composed of about fifty segments and bearing on the inner surface a fringe of long, fine hairs, which are longer and more dense at the base than beyond. Entire surface of the nymph covered with a fine coating of brownish hairs, except the head, which is quite smooth.

Gills and the mouth parts as in A. abnormis. Anal gills absent. These nymphs are commonly found in swift-running water under stones, and although little is known of their habits, they are of the carnivorous type, and apparently have a three-year life cycle.

The narrow black band on the posterior margin of the tenth abdominal tergite readily distinguishes *lycorias* from related forms.

Ithaca, N.Y.; Dansville, N.Y.; Lake George, N.Y.; Clinton, N.Y.; Ft. Ann, N.Y.; Guelph, Ont.

Acroneuria pacifica Banks

(Plate 5, figs. 71-76; plate 25, fig. 204; plate 32, fig. 224.)

Length of body up to 23 mm.; antennae up to 19 mm.; cerci up to 11 mm.

This is a western form and is most readily recognized by the

blaze upon the head in front of the anterior ocellus.

General color chestnut brown to dark brown, with lighter areas

on head and thorax.

Head a little narrower than pronotum, brown, with lighter areas on the occiput, and lighter spots on the outside of the hind ocelli, and with a whitish blaze extending forward from the anterior ocellus as indicated in Plate 32, fig. 224.

Pronotum a little more than twice as wide as long, somewhat convex on the anterior margin and slightly concave on the posterior one; lateral margins convex, angles broadly rounded; marginal groove distinct near the anterior and posterior margins, but rather faintly noticeable on the sides, which are not produced into distinct flanges.

Legs somewhat flattened, fringed thickly with long hairs.

Abdomen somewhat depressed, brown, each segment with a round yellowish spot near the posterior border along the median

line; surface covered with fine hairs, and posterior margins with a fringe of spinulose hairs; cerci composed of about thirty-five segments, each with a whorl of short spines on the posterior

margin; the cerci are devoid of long hairs.

Gills. Ten pairs of much-branched, filamentous gills; two small pairs at the outer base of the prothoracic legs; one on the outer conjunctivae between the pro- and mesothorax; two pairs at the outer base of the mesothoracic legs; one pair on the outer conjunctivae between the meso- and metathoracic legs; and one pair of large caudal gills. Some of these gills are so closely crowded that superficially the nymph appears to have only six pairs of

gills, including the anal gills.

Mouth parts. Labrum about three times as wide as long; anterior margin with a fringe of long hairs. Mandibles slightly asymmetrical, each with five distinct teeth, of which the first, second, and fourth are the largest; beyond these teeth is a fringe of long hairs. Maxillae: lacinia bidentate, with the second tooth a little more than half as long as the first; following the second tooth there is a fringe of long hairs; galea distinctly two-segmented, shorter than the lacinia, and at the tip with a small group of hairs; maxillary palpus extends considerably beyond the tip of the lacinia. Labium: submentum very broad; glossae small, triangular; paraglossae large and fleshy, directed inward at the tips, and bearing a series of long hairs.

This species is quite common in the swift-running streams of

the Western States.

Logan R., Utah; Provo R., Utah; Estes Park, Colo.; Boulder, Colo.; Yellowstone National Park; Pecos, N. Mex.; Jocko R., Mont.

Acroneuria ruralis Hagen

(Plate 24, fig. 203; plate 32, fig. 223.)

Length of body up to 24 mm.; antennae up to 11 mm.; cerci up to 25 mm.

The nymphs of this species are readily recognized by their uniform light brown to chestnut brown color, their very broad pronotum, with wide, flaring flanges; antennae not more than half as long as the body; cerci extremely long, equaling or surpassing the entire body.

Head a little narrower than pronotum, uniformly brown, except for somewhat lighter areas around the ocelli and eyes; eyes small, black, and set forward some distance from the postero-

lateral angle of the head; hind ocelli almost twice as close to each other as to the eyes; a wavy occipital ridge present. Antennae

yellowish with about seventy-five short segments.

Pronotum a little less than three times as wide as long; front margin nearly straight or slightly convex; hind margin rather deeply concave in center; sides and angles broadly rounded, the former produced into wide flanges. Meso- and metanotum similar to the pronotum in color and markings; sides of wing pads broadly rounded and bearing on the lateral margin a series of spinulose hairs; legs flattened; femora and tibiae with a thick fringe of white hairs.

Abdomen flattened, posterior margin of each segment with a row of stout hairs; cerei very long, and tapering from a rather stout base to a very slender apex; composed of about fifty-five segments, the basal segments very short, apical ones long and slender, each segment terminating in a whorl of short spines;

inner margin of cerci with a fringe of hairs.

Nine pairs of branched, filamentous gills as follows; two pairs on each of the outer bases of the pro- and mesothoracic legs; one pair at the outer base of the metathoracic legs; one pair at the lateral conjunctivae between the pro- and mesothorax; one pair between the meso- and metathorax; and two pairs on the metathorax. Each of these nine pairs of gills is much branched, and extends outward beyond the margin of the pro-, meso-, and metanotum; anal gills absent.

Fairport, Iowa.

Acroneuria theodora Needham and Claassen

(Plate 26, fig. 206.)

Length of body up to 34 mm.; antennae up to 14 mm.; cerci

up to 19 mm.

The nymphs of this species are easily confused with the nymphs of A. californica because of their close general resemblance. In A. theodora however the occllar triangle is completely covered with brown except for a small round yellow spot in the center of the triangle in some of the nymphs, while in A. californica the hind occlli are always surrounded by a transverse yellow spot. In A. californica the femora are uniformly yellowish, while in A. theodora the middle portion of the femora is darker than the rest. A. theodora is also larger than californica.

General color yellow and brown, the entire body covered with

short brown hairs.

Head a little wider than pronotum; a dark spot over the ocellar triangle except that in some nymphs there may be seen a small, round yellow spot in the middle of the ocellar triangle; hind ocelli much closer to each other than to the eyes; occipital ridge absent; antennae less than half as long as body and composed of about eighty-five segments.

Pronotum almost twice as wide as long, transversely oval; hind angles more broadly rounded than front ones; lateral flanges narrow, yellow; marginal groove distinct; surface thickly coated with brown hairs and the margin fringed with small spinules and a few longer hairs, especially on the posterior margin. Meso-and metanotum patterned with yellow and brown, and thickly coated with brown hairs. Legs flattened, and with a fringe of long white hairs.

Abdomen moderately flattened; basal half of tergites usually darker than caudal half; posterior margins brown. Cerci at least half as long as body, each of the thirty-five segments terminating

in a whorl of spines.

Gills arranged similarly to those of A. californica, but more copious, and the gill tufts at the base of the meso- and meta-thoracic legs are bunched so closely together that they appear as single tufts.

The mouth parts are very similar in structure to the mouth

parts of A. californica.

Of this species I have several reared specimens from Yellowstone National Park.

Family NEMOURIDAE

This family consists of the genera Nemoura, Taeniopteryx, Leuctra, and Perlomyia. The nymphs are small, for the most part under 15 mm. in length, and are almost wholly concolorous. They inhabit largely the small upland spring brooks and are herbivorous in food habits. The life cycle appears to be one year. It is rather difficult to assign to nymphs of this family any characteristics which will apply to all the genera included. The mouth parts are typically herbivorous. The labrum is somewhat wider than long and the epipharynx is absent. Mandibles with four or five blunt teeth followed by a molar which bears a comb of short, stout hairs, and beyond this a group of long hairs. Lacinia wide at base, at the apex with two small teeth, and partially separated from the stipes by a short incision or suture; maxillary palpus stout and much longer than galea. Glossae and paraglossae of labium almost equally long and at the tips with numerous papillae. Labial palpi short and stout, and in Taeniopteryx and Nemoura usually not extending beyond the tips of the paraglossae, while in Leuctra they may extend considerably beyond the ligula.

The wing pads in Taeniopteryx and Nemoura are wide and are directed away from the body, while in Leuctra they are narrow

and lie parallel to the body.

Gills mostly absent. In some species of Taeniopteryx coxal gills are present, and some species of Nemoura possess gills in the cer-

vical region.

In mature nymphs the venation of the wing pads can often be seen clearly, and in many nymphs the genital characters aid in identification.

Genus NEMOURA Latreille

The nymphs of this genus measure mostly less than 10 mm. in body length. They are most easily recognized by the stocky form of body, the fringe of spiny hairs around the margin of the pronotum, the spiny legs, and when gills are present they occur in the cervical region between the head and the anterior margin of the prosternum.

Head no wider than pronotum; rounded behind, somewhat hairy; ocelli noticeable in the more mature nymphs, hind ocelli a little closer to the eyes than to each other; antennae about half as long as body and composed of less than fifty segments; epication of the segments is the segments.

cranial suture distinct.

Pronotum narrowed posteriorly; angles rounded; margin with a fringe of spiny stout hairs; a distinct median pale line divides the pronotum; marginal groove indistinct. Wing pads well developed; hind wing pads much wider than front ones; the latter almost parallel to the body, the former diverging outward. Legs stout, the femora and tibiae covered with long spines; middle segment of tarsus very short; third segment as long as, or longer than, first and second combined.

Abdomen cylindrical; the segments with a row of spines on the posterior margin. Cerci more than half as long as body, each segment ending in a whorl of long hairs.

Gills are either present or absent. When present, they occur in the cervical area either as four single gill filaments or in four

groups of bunched finger-like gills.

The mouth parts are of the herbivorous type. Labrum hardly half again as wide as long; front margin nearly straight, and beset with fine hairs. Mandibles asymmetrical, with four to six unequal teeth followed by a well-developed molar which is fringed with a comb of short, stout hairs and beyond this there is a bunch of long hairs. Maxillae stout; lacinia ending in two or three teeth, followed by a fringe of hairs; galea subcylindric, extending slightly beyond the tip of lacinia, and bearing at the tip a small bunch of hairs; maxillary palpus stout, even the longest segments hardly twice as long as wide. Labium longer than wide; submentum large, wider than long; mentum a narrow transverse band; glossae and paraglossae subequal in length, but the paraglossae about twice as wide as the glossae; labial palpus stout, scarcely reaching beyond the tip of the paraglossae; last segment of palpus more or less egg-shaped and directed inward. Hypopharynx rather small and normally not extending beyond the tip of the glossae.

The sexes differ as follows: in the male the tenth abdominal tergite is somewhat prolonged into a short rounded supra-anal lobe; the ninth sternite is produced, and the tenth sternite divided. In the female the tenth abdominal tergite is broadly rounded; the ninth sternite is not so much produced and the tenth sternite although very narrow is not so completely divided as in the male. In fully mature nymphs the detailed genital

structures often may be distinctly noted.

The nymphs of this genus occur in small upland brooks where they live chiefly in leaf drifts. They feed upon decaying vegetation and various forms of algae, such as diatoms. Wu (57) has worked out the complete life history of *N. vallicularia* which he

found to pass through twenty-two instars, and the life cycle occupied one year.

Key to the known Nymphs of Nemoura

1.	No gills in cervical region	
	Gills present 2	

4. Each group composed of 6-7 filaments.....N. venosa (p. 95) Each group composed of 8-9 filaments.N. coloradensis (p. 96)

Nemoura sinuata Wu

(Plate 28, fig. 209; plate 32, fig. 226.)

Length of body up to 6.5 mm.; antennae up to 4 mm.; cerci up to 4.5 mm.

General color yellow to yellowish brown.

Head about as wide as pronotum; surface covered with fine hairs; basal stem of epicranial suture more than half as long as the lateral arms; hind ocelli (showing in mature nymphs) a little closer to eyes than to each other; antennae of about forty-five segments.

Pronotum narrowed posteriorly; front margin somewhat convex or nearly straight; angles rounded; surface dirty brown; margin fringed with short blunt spinules. Meso- and metanotum with some long hairs and with short spinules on the lateral margins, especially at the antero-lateral angles; front wing pads narrower and longer than the hind ones, which diverge greatly from the body. Legs stout, the femora and tibiae covered with many stout spine-like hairs.

Abdominal segments with a fringe of hairs on the posterior margin. Cerci long and slender, of about thirty-two segments, each segment terminating in a whorl of long hairs. In the male the tenth abdominal tergite is produced into a short broad supraanal protuberance, which is absent in the female; eighth sternite of female with a depressed area in the center of the posterior margin, denoting the developing genital opening.

Four groups of gills in the cervical region just anterior to the prosternum; two outer groups contain seven gill filaments each,

and the inner ones about seventeen.

Mouth parts. Labrum nearly half again as wide as long; anterior margin nearly straight and with a fringe of short hairs. Mandibles with four or five unequal teeth followed by a well-developed molar which is fringed with a comb of short, closely set, blunt hairs; beyond the comb is a bunch of longer hairs. Maxillae stout; lacinia terminating in two or three denticles, followed by a fringe of hairs; galea cylindric, extending a little beyond the tip of lacinia and at the tip with a few hairs; maxillary palpus stout and extending far beyond the tip of the lacinia. Labium: mentum very narrow; submentum large, subquadrangular; glossae and paraglossae about equally long but the paraglossae much wider than the glossae; at the tip the glossae and paraglossae bear small papillae; labial palpi very stout and not extending much beyond the tip of the paraglossae; third segment of labial palpus very large.

In general appearance these nymphs are of a dirty brown color, due to the adherence of small particles of organic matter. The spiny legs and the fringe of short stout spines around the margin of the pronotum as well as at the anterior angles of the meso- and metanotum are characteristic of Nemoura.

The nymphs occur largely in small upland streams where they may be found in the leaf drift.

Ithaca, N.Y.

Nemoura vallicularia Wu

Length of body up to 7 mm.; antennae up to 4 mm.; cerci up to 4 mm.

In general appearance very similar to *N. sinuata*. The nymphs, however, have no gills in the cervical region. Wu (57) who has studied the morphology and biology of this species found that it passes through twenty-two instars and completes its life cycle in one year.

Ithaca, N.Y.

Nemoura venosa Banks

(Plate 9, figs. 141-146.)

Length of body up to 6.5 mm.; antennae up to 3.8 mm.; cerci up to 3.7 mm.

General color yellowish brown to darker brown. Very similar in appearance to N. sinuata but differs as follows: the gills in the cervical region are in four groups, each group made up of six to seven finger-like gills. The fringe of hairs around the margin of the pronotum and on the antero-lateral angles of the meso- and

metanotum seem to be a little longer in this species than in N. sinuata but this difference is not sufficient to be of much aid in separating the species. In fully mature nymphs the developing genital structures are of considerable aid in identification.

Ithaca, N.Y.

Nemoura coloradensis Banks

Length of body up to 6.8 mm.; antennae up to 4 (?) mm.; cerei up to 4 (?) mm.

General color brown to dark brown.

It is with some doubt that I include this species, for the nymphs before me have not been reared. However, they are mature and show the genital structures fairly well. The gills are present in the cervical region in four groups, with eight gill filaments in the outer group, and eight to nine in the inner group. The fringe of hairs on the pronotum, and the arrangement of the spines on the legs, are similar to *N. sinuata*. In the male nymphs the subanal lobes are large, somewhat subquadrate, and a little upturned.

Nymphs from Bozeman, Mont.

Nemoura sp.

Among the collection of Nemoura nymphs, I have a number of alcoholic specimens from Colorado which differ markedly from

any of the Nemoura nymphs described in this paper.

In the cervical region, there are four single large finger-like gills. The legs are covered with spiny hairs, and on each of the femora, beyond the middle, there is a diagonal transverse row of long spine-like hairs. This row of spines is continuous in the femora of the pro-, and mesothoracic legs, but in the femora of the metathoracic legs the row of spines is interrupted by a gap. In other details these nymphs resemble other species within the genus.

Genus LEUCTRA Stephens

The nymphs of this genus are most readily recognized by the slender form of body and the shape and position of the wing pads. The wing pads are long and narrow and lie parallel with the body, the mesothoracic ones are set far apart at the base, while the metathoracic are set close together.

General color yellowish brown to darker brown. Fully mature nymphs measure 10 mm. or less in body length. Antennae and cerci well developed, being normally about half as long as the

body.

Head wider than pronotum; broadly rounded behind; rather smooth; three ocelli, the posterior ones about twice as close to the eyes as to each other.

Pronotum about as wide as or slightly wider than long; sides nearly straight; angles rounded; surface somewhat hairy, especially around the outer margin; anterior marginal groove indistinct. Legs rather stocky and only sparsely clothed with long hairs; first segment of tarsus at least twice as long as second; sometimes the second is indistinct; third much longer than one and two combined.

Abdomen cylindric, covered with short hairs, and with a fringe of short hairs on the posterior margin of each segment.

Gills absent.

The sexes are not so readily recognizable as in some other genera. The males are smaller and a little more slender than the females. In the males may be noticed a small protuberance in which the supra-anal process develops.

The mouth parts are of the herbivorous type and indicate that all the species in the genus are vegetable feeders. The labium is different in structure from the labia in related genera, in that the glossae are only about half as wide as the paraglossae, and the labial palpus extends much beyond the paraglossae. In general, the structure of the mouth parts is so similar in the different species within a genus that the description and figures of the mouth parts of L. sibleyi may well be said to describe the general structure of the mouth parts of the entire genus.

The nymphs are commonly found in small upland streams where they occur in leaf drifts and other forms of vegetable matter. Because of their inconspicuous brown color and small size, and their habit of clinging to brown leaves and sticks, the nymphs are not readily observed, and are therefore quite scarce in collections.

Although we have no records of any life-history studies within the genus, they probably require one year to complete the life cycle. The adults of most species emerge in the summer, although some are found emerging as early as March and others as late as November.

I have been able to identify with certainty the nymphs of only two species, L. decepta and L. sibleyi. Judging from the close similarity in the shape, size, color, and structure of the nymphs of these two species to the many other nymphs in the collection from various localities, it appears that specific identification in this genus will be very difficult. No reliable characters have yet

been discovered which will separate the two above species or which distinguish them from *L. claasseni* Frison, recently described by Frison (6). Identification can, therefore, at present be made only by rearing each nymph, or else by careful dissection and examination of the developing genital structures in mature nymphs.

Leuctra sibleyi Claassen

(Plate 9, figs. 147-152.)

Length of body up to 8 mm.; antennae up to 3.8 mm.; cerci up to 4 (?) mm.

General color yellowish brown to darker brown.

Head considerably wider than pronotum; rounded behind; hind ocelli at least twice as close to the eyes as to each other; front ocellus placed on a line in front of the anterior margin of the compound eyes; surface smooth; antennae about half as long

as body, with about forty-eight segments.

Pronotum only slightly wider than long; sides nearly straight; angles rounded, the posterior ones more so than the anterior ones; surface nearly smooth, slightly hairy, and with longer hairs on the outer margins at the angles; anterior marginal groove narrow and not prominent. Hind wing pads set closely together so that the inner margins are almost contiguous. Legs rather short, stocky and not much flattened; sparsely covered with short hairs, and only a very few longer hairs on the femora and tibiae; first tarsal segment more than twice as long as second; third almost twice as long as one and two combined.

Abdomen cylindrical, rather slender and somewhat widened near the middle; sides of segments nearly straight; surface covered with short stout hairs, and the posterior margin with a series of short spinules; tenth tergite broadly rounded in both male and female nymphs. In the male there appears a small lobe-like protuberance just below the tenth abdominal tergite; within this protuberance, the supra-anal process may be seen in mature nymphs. Cerci rather stout and at least half as long as the body; the basal segments slightly wider than long; near the middle they are about three times as long as wide, and at the tip at least six times as long as wide; there are about eighteen or twenty segments in each cercus, each segment with a whorl of long hairs near the apex.

Mouth parts. Labrum at least half again as wide as long; anterior margin slightly concave in the middle and fringed with

many short hairs. Mandibles asymmetrical, four unequal, rather blunt teeth, followed by a well-developed molar which on the dorsal surface is fringed by wide blunt hairs resembling a comb; beyond this comb, a small group of long hairs. Maxillae: lacinia terminating in two incurved teeth followed by a fringe of stout hairs; galea cylindrical, extending somewhat beyond the lacinia, and bearing at the apex a group of small papillae and a few setae. Maxillary palpus nearly twice as long as galea, stout, the fifth segment with a small cup at the apex in which may be noted small papillae. Labium with submentum very large and almost as long as wide; mentum very narrow; glossae and paraglossae small; the glossae only about half as wide as paraglossae and not extending beyond the paraglossae. Both glossae and paraglossae covered at the tip with small papillae, but only the paraglossae with long hairs; labial palpus stout and reaching far beyond the tip of the paraglossae; third segment ending in a cup-shaped depression. Hypopharynx large, rounded in front, and normally extending far beyond the tips of the paraglossae.

Ithaca, N.Y.

Leuctra decepta Claassen

(Plate 28, fig. 208.)

Length of body up to 8 mm.; antennae up to 4 (?) mm.; cerci up to 3.5 (?) mm.

General color brown with the appendages a little lighter. Head wider than pronotum; hind ocelli more than twice as close to the eyes as to each other; antennae composed of about forty-five segments.

Pronotum a little wider than long; sides nearly straight or slightly convex; angles rather narrowly rounded; surface quite smooth, covered with hairs, and with longer hairs on the outer margin, especially noticeable at the angles. Cerci with about twenty segments. In fully mature nymphs, the genital structures of the developing adult may be observed. In the male there occurs a small tubercle just beyond and below the tenth tergite. Within this tubercle may be seen the developing supra-anal processes.

No nymphal structures have been found by which this species can definitely be separated from other species, and identification is possible only through rearing records or by careful study of the genital structures in mature nymphs.

Ithaca, N.Y.

Leuctra claasseni Frison

The following description is taken from Frison (6).

Nymphal Male. General color yellow-brown, general body form elongate; about 8 mm. long.

Head much wider than prothorax, widest at compound eyes, rounded behind; epicranial stem about as long as one-half of width of prothorax; developing ocelli in same relative positions as in adult; labrum somewhat perpendicular to plane of front. Antennae long and slender, fifty or more segments in each antennae; first segment very large, basal segments wider than long, succeeding segments gradually becoming more elongate and with apical segments several times as long as wide, a few setae on segments.

Labium with glossa divided into two parts by an incision which extends longitudinally as a suture less than one-half the length of the ligula; paraglossae about as broad as glossae combined, and not extending beyond them; palpiger distinct and almost appearing as short basal segment of palpus; labial palpus threesegmented, basal segment shortest, second and third segments longer than first, and of about equal length, third or terminal, segment less broad than second, and gradually rounded and tapering at apex. Hypopharynx about as large as ligula, lobe-like, rounded at apex, and not extending beyond glossae. Maxillae well developed; lacinia with two slender, sharp teeth curved inwards at apex, beneath which on inner side is a row of long stiff setae: galea extending slightly beyond lacinia, curved and tapering to a point at apex; palpifer indistinct, and appearing as basal segment of palpus, maxillary palpi five-segmented and about twice as long as labial palpi, basal or first segment very short and likely to be confused with palpifer, second segment shortest and about one-half as long as fifth, third and fourth segments subequal, fifth segment a little longer than third. Mandibles heavily chitinized, with several teeth directed inwardly near apex, beneath which on inner margin is a well-developed molar with short stiff setae.

Pronotum with darkly chitinized area almost quadrate, with front angles slightly rounded and hind angles conspicuously so. Meso- and metathorax supporting wing pads which extend backwards nearly parallel with body. Fore wing pads long and narrow, overlapping basal third of hind wing pads. Hind wing pads likewise, long and narrow, with anal lobe not extending much beyond middle of wing pad; venation of wing pad, when dis-

tinguishable, typical of genus, with numerous cross-veins between medio-cubital longitudinal veins. Legs short, prothoracic legs shortest, metathoracic legs longest, femur and tibia of about equal length, femur much broader than tibia; tarsi three-segmented, second segment very small, third segment two or three times as long as first, and provided with two simple claws at apex; tibia at apex lower on side with two spines about one-third as long as the first tarsal segment; some short stout setae on ventral aspect of all segments.

Abdomen appearing cylindrical, with lateral margins of segments almost straight and not noticeably tapering towards the apex; first seven dorsal segments of about equal size, and slightly broader than long, eighth and ninth dorsal segments about twice as broad as long, tenth dorsal segment rounded behind, and from lateral aspect somewhat lobe-like and humped up at apex; ninth ventral segment with faint indication of lobe-like appendage visible through body, which is a large anal area somewhat pointed on posterior margin and longitudinally bisected by an incision for one-half of its length. Anal cerci, at least nineteen in one specimen; first few basal segments about as long as wide, succeeding segments rapidly becoming much longer than wide, those towards apex much broader at apex than at base, and with a row of long stiff setae around each segment near apex.

Nymphal Female. Similar in general to the male. Abdominal segments as a whole much broader than long, apical dorsal segment broadly rounded behind and without hump-like lobe at apex,

when viewed from lateral aspect.

Harrisburg, Ill.; Herod, Ill.

Genus TAENIOPTERYX Pictet

The nymphs of this genus are mostly blackish in color, in some instances yellowish brown, and in some species with a median, narrow, yellowish, longitudinal line, especially noticeable on the thorax; antennae and cerci very long and slender. The nymphs, when fully grown, measure from 10 to 14 mm, in body length.

Head a little narrower than pronotum; three small ocelli, of which the posterior ones are at least twice as close to the eyes as to each other; occiput marked with numerous granular markings.

Pronotum somewhat widened posteriorly, angles rounded, and the sides slightly convex; surface somewhat rugulose; marginal groove rather indistinct; front wing pads slender and somewhat directed outward, so that the posterior margin is almost at right angles with the long axis of the body. Legs long, slender, and not very much depressed; outer margins of femora and tibiae with a thin fringe of long hair; first and second tarsal segments subequal, the two together about as long as the third.

Abdomen nearly cylindrical; cerci long and slender.

In some of the species there are present three pairs of three-segmented, filamentous gills attached to the inner side of the coxae. These gills are telescopic in nature and may be shortened or lengthened.

Mouth parts of the herbivorous type; the labrum not more than half again as wide as long, slightly emarginate in the middle of the anterior border which bears a fringe of hairs. Mandibles somewhat asymmetrical, with four or five rather blunt teeth; these teeth are followed by a molar and a fringe of short stout hairs with longer hairs beyond. Maxillae: lacinia triangular, broad at the base, terminating in a broad bluntly pointed tooth which is followed by a series of long hairs. Galea large, two-segmented, reaching to the tip of the lacinia, and bearing at the apex numerous small tubercles. Maxillary palpus, when fully extended, reaches beyond the tip of the lacinia; first and second segments not longer than wide: third segment a little longer than first and second combined; fourth a little shorter than third, and the last segment about as long as the third; entire palpus very stout. Labium much longer than wide; glossae and paraglossae about equal in length, although in some specimens the glossae seem to be a little longer than the paraglossae; both glossae and paraglossae bear at the apex numerous small tubercles, and the paraglossae also bear long hairs; labial palpi very short and heavy; first segment only about half as long as wide; the second hardly longer than wide, and the third very slightly longer than wide; entire palpus does not reach beyond the tips of the paraglossae. Mentum quite wide; hypopharynx rounded at the tip and extending nearly to the tip of the glossae.

The nymphs of this genus are found in slowly-running water, and at times may occur in fresh-water ponds or pools. They are herbivorous, feeding entirely on vegetation. The life cycle apparently occupies but one year; they mature early in spring, and in the vicinity of Ithaca, begin to emerge in February. Adults may be found as late as April. When ready to transform the nymphs crawl up on the vegetation bordering the ponds and streams, and cast skins may often be found there. The adults are

poor fliers, and remain near the streams where they may be collected by sweeping the vegetation, or sometimes they may be clubbed off the trees along the banks. Very little is known about the habits of the nymphs and adults except that Newcomer (32) has reported that the adults of *T. pacifica* sometimes cause injury by feeding upon fruit buds in the orchards along streams, and Frison (6) reports them to be feeding on Protococcus.

Key to the Nymphs of Taeniopteryx

1.	Coxae with seg	mented trache	eal appendages	2
	Coxae without	tracheal gills		4

- - Without a distinct mid-dorsal stripe; males without ventral lobe-like appendage parvula (p. 105)
- 3. Length of body up to 14 mm., general color dark brown to blackish; males without tooth on hind femora; commonest of the eastern species of this genus. nivalis (p. 103) Length up to 10 mm., general color yellowish to light brown;
- males with a tooth on hind femoramaura (p. 104)
 4. Ventral appendage of ninth abdominal sternite triangularly produced in the female, while in the male this appendage is more square and slightly unturned at the tip.

Taeniopteryx nivalis Fitch

(Plate 9, figs. 135-140; plate 29, fig. 210; plate 33, fig. 229.)

Length of body up to 14 mm.; antennae up to 9 mm.; cerci up to 8 mm.

General color dark brown to blackish, with lighter markings, and usually with a very distinct median, dorsal, yellow line extending from the head to the tip of the abdomen.

Head somewhat narrower than pronotum; yellowish or brown, with darker mottled areas over the occiput behind the ocellar triangle, and a dark area in front of the latter, as well as a darker spot at the base of the antennae near the eyes. Three small ocelli, the posterior ones at least three times as close to the eyes as to each other, and set forward on the head so as to be in almost

direct line with the center of the compound eyes. In the lighter specimens, the ocelli are readily seen because of the small darker markings inside of the ocelli. Antennae long and slender, with

about eighty segments.

Pronotum a little wider than long, with rounded angles; sides somewhat convex; front margin slightly concave in the center; surface quite rugose; brown or black in color, with the lateral margins yellowish, and in most specimens with a distinct yellow median line, or else a slight indication of one. Meso- and metanotum yellowish brown or darker, smoother than pronotum; mesothoracic wing pads diverge from the body at an angle of about thirty degrees, with the outer margins nearly straight; the hind wing pads diverge more from the body than do the front wing ones, so that the posterior margin is almost at right angles to the long axis of the body, especially noticeable in mature nymphs. Legs slightly flattened, somewhat hairy; outer margins of the tibiae with a sparse fringe of long fine hairs; first and second tarsal segments subequal, the two together about as long as the third segment.

Abdomen nearly cylindrical; surface covered with very short brown spinules; basal half of each segment usually darker than the distal half, and in most specimens the median line is very noticeable; cerci brown at the base, becoming lighter towards

the tip.

Gills. There are three pairs of gills attached to the coxae on the inner base of the legs and they are made up of three segments, the basal largest, and the following two segments successively smaller. These gills are telescopic, and when fully extended they reach to about the middle of the femora.

In the more mature nymphs the sexes can readily be differentiated. In the male, the supra-anal process projects beyond the posterior margin of the tenth tergite in the form of a slightly upturned, short knob and the ventral lobe of the ninth sternite is often plainly visible through the integument. In the female nymph the tenth tergite terminates in a flattened rounded prolongation.

Ithaca, N.Y.; Clinton, N.Y.; Illinois.

Taeniopteryx maura Pictet

Length of body up to 10 mm.; antennae up to 7.5 mm.; cerci up to 6 mm.

General color yellowish with brown markings.

Head a little narrower than pronotum; entire occiput covered with mottled brown marks; there is also a brown spot each side of the ocellar triangle at the base of the antennae, and another in front of the anterior ocellus; hind ocelli at least twice as close to the eyes as to each other; surface very feebly pilose; antennae long, slender, brown at the base and lighter toward the tip; of about seventy-five to eighty segments.

Pronotum a little wider than long, slightly widened posteriorly; angles rather broadly rounded; a broad, median, yellow stripe, on each side of which the rugose discs are of a darker brown color, or else there are dark markings upon a lighter background; meso- and metanotum brownish; metathoracic wing pads directed away from the long axis of the body, so that the hind margins are almost at right angles to the body.

Legs somewhat flattened; tibiae with a sparse fringe of long, fine hairs on the outer margins; first and second tarsal segments about equal in length, the two together at least as long as the third segment.

Abdomen nearly cylindrical, more or less uniformly brownish, but in more mature nymphs, the mottled appearance of the developing adult may be seen through the chitin; ventral surface of body light in color. There are three pairs of segmented, telescopic, filamentous gills attached at the inner base of the coxae as in *T. nivalis*.

The sexes in this species are readily separated. In the female the ninth abdominal sternite is hardly produced at all; the tenth tergite is broadly rounded on the posterior margin. In the male, the ninth sternite is somewhat produced rearward, and the tenth tergite bears in the center of the posterior margin a projected lobe in which the developing supra-anal process lies. In the mature nymphs, the detailed genital structures can readily be observed through the chitin, especially after the specimens have been in alcohol for some time. Likewise, the tooth on the femora can readily be seen in the male. The smaller size and the relatively lighter color distinguish this species from $T.\ nivalis$.

Plummer's Island, Md.; Washington, D.C.

Taeniopteryx parvula Banks

Male. Length of body up to 7 mm.; antennae up to 5 mm.; cerci 4 mm.

General color yellowish brown with some darker mottlings on the head and some more or less indistinct darker markings on the rest of the body. Head about as wide as pronotum; mottled brown; a dark spot in front of the anterior ocellus; two dark spots on the inner margin of each eye; hind ocelli a little more than twice as close to the eyes as to each other; antennae with about seventy-five segments.

Pronotum a little wider than long, brown, with a lighter margin, especially noticeable in front and rear; angles broadly rounded; surface not very rugose. Meso- and metanotum brownish; legs somewhat flattened; tibiae with a sparse fringe of long hairs on the outer margin; first and second tarsal segments sub-

equal, together as long as the third.

Abdomen nearly cylindrical, yellowish brown; cerci yellowish with about forty segments. There are three pairs of filamentous, three-segmented, telescopic gills attached to the inner base of the coxae; ninth abdominal sternite somewhat swollen and slightly produced rearward; tenth tergite medially produced into an upturned, rounded knob, in which develops the supra-anal process.

Two males from Plummers Island, Maryland, February 24,

1923, Warner, Barber and Currie.

The above description is made from two mature male nymphs in which the genital structures can be seen very clearly.

Taeniopteryx fasciata Burmeister

(Plate 29, figs. 215-216.)

Length of body up to 8.5 mm.; antennae up to 5 mm.; cerci up to 8 mm.

General color yellow, mottled with brown.

Head a little narrower than pronotum, yellowish with brown mottled markings on the occiput, and with a more or less distinct brown band across the ocellar triangle reaching from the base of one antenna to the other; a brown U-shaped mark in front of the anterior ocellus; hind ocelli about twice as close to the eyes as to each other; antennae yellowish with the first two basal segments darker and also somewhat darkened toward the tip, composed of about sixty-five segments.

Pronotum a little wider than long, yellowish, with darker, rugose lateral fields; the front and hind margins also somewhat darker; front angles rather narrowly rounded, hind ones broadly so; lateral margins somewhat convex, so that the pronotum appears to be somewhat broadened posteriorly. Meso- and metanotum yellowish, with brown markings; wing pads almost uni-

formly yellowish brown; the hind wing pads directed away from the body slightly more than the front ones, but not quite so much so as in *T. nivalis*.

Legs flattened, yellow; the femora with a more or less distinct transverse band beyond the middle; both femora and tibiae with a fringe of long hairs on the outer margin; first two tarsal segments about equal in length, and together a little shorter than the third segment.

Abdomen somewhat flattened; yellowish, with brown mottlings over the basal half of each segment, and with brown, short hairs over the entire surface; cerei long and slender.

Gills absent.

The sexes are easily distinguished. In the female, the ninth abdominal sternite is prolonged into a hairy, tongue-like plate which projects normally beyond the tip of the abdomen. In the male the ninth abdominal sternite is produced in a wide, flattened plate which gradually tapers almost to the tip, then turns up in a square process, very similar to the subgenital plate of the adults; the tenth tergite has a small median projection on the posterior margin, within which develops the supra-anal process. The larger size of the subgenital plate, and the fact that in the male it turns up and projects far beyond the end of the abdomen, readily distinguish the male from the female.

Plummer's Island, Md.; Illinois.

Taeniopteryx californica Needham and Claassen

Male. Length of body up to 10 mm.; antennae up to 7 mm.; cerci up to 8 mm.

General color yellowish brown with darker markings on the body and with wide, brownish, transverse bands on the femora, sometimes only faintly indicated.

Head narrower than pronotum; brown, with a yellow area just back of the ocellar triangle, and with a lighter yellow area in front of the anterior ocellus; hind ocelli at least twice as close to the eyes as to each other; antennae light brown, slightly more infuscated toward the tip.

Pronotum a little wider than long, brown, with a lighter area in the center of each lateral disc; surface nearly smooth, except for the more or less crescentic, irregular, embossed markings; angles broadly rounded. Meso- and metanotum marked with yellow and brown; front wing pads diverging only slightly from the body; hind wing pads diverging at about a 20° angle. Legs

somewhat depressed; the femora with a faint transverse, brownish band; a fringe of long hairs on the outer margin of femora and tibiae; first segment of tarsus shorter than second; from a dorsal view it appears to be only one-third as long, but on the ventral side it is nearly as long as the second; segments one and

two together shorter than three.

Abdomen very nearly cylindric, light brown with a few scattered brown freekles on the basal half of each segment; cerci yellowish except for a very narrow, brown band at the apical margin, and composed of about fifty segments. The tenth abdominal tergite in the male is produced into a tubercle-like projection; ninth abdominal sternite produced into a broad, flattened, subgenital plate, which is produced to the tip of the abdomen.

Gills absent.

Described from three male nymphs collected at Spencer Creek,

Ithaca, New York, April 5, 1926. P. R. Needham.

This species was originally described from California, but within the last few years it has been found in several localities in New York. Adults have been collected at Spencer, New York, April 5, 1926 (P. R. Needham), and at Copak Falls, New York, April 11, 1924 (Crosby and Chapman).

Family CAPNIIDAE

Small brown or blackish nymphs, under 10 mm. in body length. They are true herbivores and largely inhabit the small upland spring brooks. The life cycle is completed in one year. Antennae and cerci are long and slender; second tarsal segment much shorter than first; third tarsal segment at least twice as long as first and second combined. Legs with a sparse fringe of long hairs. Gills absent. Mouth parts similar to those of the Nemouridae. Wing pads when present lie parallel to the body, and the hind are wider than the front ones. In the males, the last abdominal tergite ends in a conical projection, while in the female nymphs it is only slightly produced, and broadly rounded.

Genus CAPNIA Pictet

The nymphs of this genus resemble those of Allocapnia, but differ in the shape of the wing pads. The metathoracic wing pads are similar to the mesothoracic ones except that they are a little wider. The anal field of the hind wing pad is narrow and short, only reaching a little beyond the middle of the wing pad. Since the nymph of only one species (C. vernalis Newpt.) is known it is impossible to give an adequate description of the genus. Capnia is essentially a western genus, eighteen of the nineteen described species being known from the Rocky Mountains and the western states. Of these not a single species has been reared. I have several western nymphs before me but they are not fully mature and cannot be specifically determined. C. vernalis, the only species of the genus occurring east of the Rocky Mountains, has been collected in a number of places in New York State, where the adults may be found during March and April. Since C. vernalis is a herbivore, it is probably safe to assume that all the species within this genus are herbivorous.

Capnia vernalis Newport

(Plate 10, figs. 159-163; plate 30, fig. 217.)

Length of body up to 7.5 mm.; antennae up to 3.6 mm.; cerci up to 4 mm.

General color brown, becoming darker as the nymphs near maturity.

Head a little wider than pronotum; rather sparsely coated with long hairs; surface quite smooth; hind ocelli about twice as

close to the eyes as to each other; antennae long and made up of

about fifty-six segments.

Pronotum hardly longer than wide; widened posteriorly, the sides normally broadly convex with rounded angles; surface rather smooth, and covered with long hairs, especially around the margin; marginal groove noticeable only along the anterior margin. Wing pads of female much larger than those of male. In some of the male nymphs the wing pads are very small, and such nymphs undoubtedly give rise to the brachypterous adults. Front wing pads nearly as wide as hind ones, lying either parallel with the body, or more often somewhat converging posteriorly; hind wing pads more or less parallel, the anal area hardly reaching beyond the middle of the wing case; wing pads with long hairs, especially around the margins. Legs hairy and with a sparse fringe of long hairs on the outer margin; first tarsal segment at least twice as long as second.

Abdomen subcylindric; widest in the middle portion, hairy, especially on the posterior margins of the individual segments; cerci made up of thirty to thirty-five segments, each terminating in a whorl of hairs, some of which are longer than the segments. The sexes are readily recognizable. In the female, the tenth abdominal tergite is broadly rounded and slightly produced, but otherwise unmodified. In the male, the tenth tergite is similar to that of the female except that in the middle, and somewhat below the posterior margin, it bears a short tubercle less than half as long as the tenth tergite. Within this tubercle develops the supra-

anal process of the adult male.

Gills absent.

Mouth parts of the herbivorous type, as in Allocapnia.

Labrum less than twice as wide as long; front margin normally somewhat concave in the middle; surface sparsely coated with long hairs and on the anterior margin with a thick fringe of short ones. Mandibles asymmetrical, with about five or six teeth, which in some specimens are sharp, and in others quite blunt; beyond these teeth a rather narrow molar and a series of stiff hairs. Maxillae: lacinia terminating in several blunt denticles followed by a fringe of hairs. Galea about as long as lacinia, at the apex a number of small tubercles and long hairs. Labium similar in structure to that of Allocapnia except that the glossae in *C. vernalis* are as long as, or slightly longer than, the paraglossae. Both glossae and paraglossae bear at the tips many small tubercles and hairs. Labial palpus does not extend to the tip of the paraglossae. Hypo-

pharynx broadly rounded and normally extended beyond the glossae.

The nymphs of this species are herbivorous and may be found in small upland streams where they usually occur in leaves and debris.

Ithaca, N.Y.

Genus ALLOCAPNIA Claassen

Allocapnia Claassen, Annals Ent. Soc. Amer., vol. 21, 1928, p. 667, to replace Capnella Claassen, preoccupied.

The nymphs of this genus are most readily recognized by the shape of the hind wing pads. It is the only genus in which the anal field of the hind wing extends almost to the tip of the wing, giving the wing pad a broadly triangular shape. The front wing pads are slender, set far apart at the base, and lie parallel to the body. The nymphs when fully grown seldom measure more than 8 mm. in length, exclusive of antennae and cerci.

General color yellowish to dark brown.

Head as wide as, or slightly wider than pronotum. Three ocelli, the hind ones about twice as close to the eyes as to each other. Antennae long and slender, about half as long as body, and made up of about forty-five to forty-eight segments.

Pronotum subquadrate with rounded angles; somewhat widened posteriorly; surface moderately hairy; marginal groove noticeable along the anterior margin. Wing pads present in all species except in the males of A. vivipara where they are either absent or vestigial. Legs rather short; femora and tibiae covered with hairs and with a sparse fringe of long hairs on the outer margins; first segment of tarsus about twice as long as second; third about twice as long as first and second combined.

Abdomen cylindrical. The sexes are readily distinguishable. In the male, the tenth tergite is produced into a long triangular protuberance (supra-anal lobe) which is directed slightly upwards. In the female, the tenth tergite is only slightly produced into a broadly rounded lobe. Cerci long and slender, normally about half as long as body, composed of about twenty-five to thirty segments, each segment ending in a whorl of long hairs.

Gills absent.

The mouth parts are of the herbivorous type, and their structure is so similar in the different species of the genus that they apparently are of little taxonomic value in separating the species.

Very little detailed work has been done to determine the exact

food habits of the nymphs of this genus. Examination of stomach contents, however, has shown that they are herbivores, feeding largely on decaying vegetation. Frison (6) has studied the food habits of several species in this genus, and he found them to feed on "fragments of decaying leaves and diatoms."

1 CATLOCADNIA

Key to the Nymphs of ALLOCAPNIA
1. Last segment of abdomen prolonged into a conspicuous coni-
cal protuberance (males*)
Last abdominal tergite broadly rounded, without a protuber-
ance (females*).
2. Wing pads absent or vestigialvivipara (p. 114)
Wing pads well developed (in some cases the wing pads are
abbreviated) 3
3. Protuberance of tenth tergite no longer than the ninth ab-
dominal tergiterecta (p. 113)
probably incisura (p. 115)
Protuberance longer than ninth abdominal tergite
pygmaea (p. 112)
granutata (p. 114)
. mystica (p. 116)

Allocapnia pygmaea Burmeister

(Plate 10, figs. 153-158; Plate 30, fig. 218.)

Length of body up to 8 mm.; antennae up to 3.2 mm.; cerci

up to 3 mm.

General color brown, becoming darker as the nymphs mature. Head slightly wider than pronotum; surface nearly smooth but in the maturer nymphs the occipital rugosities of the developing adult are quite noticeable; ocelli indistinct in some specimens; hind ocelli about twice as close to the eyes as to each other; antennae brown, smooth, with about forty-six to forty-eight segments.

Pronotum about as wide as long, somewhat widened posteriorly; angles rather broadly rounded; front margin convex, hind margin nearly straight; surface somewhat rugose, pilose, with longer hairs on the outer margins. In mature nymphs the dark brown markings of the developing adult are very noticeable. Wing pads large; front ones far apart, directed backward and parallel to the body; hind ones much wider than the front pair, broadly triangular, and much closer together. Legs yellowish, flattened and

* Mature male nymphs can usually be specifically identified by the structures of the developing genitalia. In female nymphs the species can not be separated.

hairy; femora and tibiae with a sparse fringe of long hairs on the margins; first tarsal segment about twice as long as second; third about twice as long as first and second combined.

Abdomen nearly cylindrical, uniformly brown in younger nymphs but transversely banded in mature ones; segments widened posteriorly; surface somewhat hairy, with a fringe of long hairs on the posterior margin of the segments. Cerci of about twenty-six segments, each terminating in a whorl of hairs.

Mouth parts. Labrum not quite twice as wide as long; anterior margin slightly emarginate in the middle, and fringed with hairs. Mandibles slightly asymmetrical, with four to five unequal, rather bluntly pointed teeth. These teeth are followed by a well-developed molar which bears very short spine-like hairs on the center, and on the outer margin is fringed with longer hairs. Maxillae: lacinia with two or three small terminal teeth followed by a few short spines and a fringe of stout hairs. Galea as long as lacinia, rather wide in the middle, rounded at the tip, which bears a few long hairs; maxillary palpus nearly twice as long as galea, stout; first and second segments about as wide as long; third segment a little less than twice as long as wide; terminal segment about as long as third but much more slender. Labium much longer than wide: submentum very large, a little wider than long; mentum a narrow transverse band; the paraglossae extend slightly beyond the glossae; tips of the glossae and paraglossae with long hairs and a few papillae; palpus short and stout, normally not extending beyond the tip of the paraglossae. Hypopharynx broadly rounded, closely beset with short hairs and normally extending beyond the glossae.

This is the most common species of the genus.

Allocapnia recta Claassen

Length of body up to 7.5 mm.; antennae up to 3.5 mm.; cerci up to 4 mm.

General color brown with the appendages somewhat lighter. This species very closely resembles A. pygmaea in appearance, but the caudal protuberance of the male in recta is much shorter than in pygmaea.

Head a little wider than pronotum; surface nearly smooth, with a feeble coating of fine hairs; antennae composed of about forty-seven segments; hind ocelli about twice as close to the eyes as to each other.

Pronotum widened posteriorly; angles broadly rounded; surface hairy; anterior marginal groove rather prominent; wing

pads prominent; front ones of the male somewhat overlapping the hind ones, while in the mature female nymph the front ones may extend as far as the posterior margin of the metanotum; hind wing pads broadly triangular. Abdomen cylindrical and somewhat hairy; tenth tergite of male produced into a short, triangular tubercle which is directed slightly upwards, and no longer than the ninth tergite. Cerci made up of about thirty segments, each segment terminating in a whorl of hairs.

Positive identification is possible only in mature nymphs in

which the genital structures may be noted.

Ithaca, N.Y.; Oakwood, Ill.

Allocapnia granulata Claassen

Length of body up to 8 mm.; antennae up to 4.3 mm.; cerci up to 3.8 mm.

General color light to darker brown.

Head as wide as or slightly wider than pronotum; hind ocelli about twice as close to the eyes as to each other; antennae of

about forty-five segments.

Pronotum widened posteriorly, hairy, angles broadly rounded; anterior marginal groove distinct but shallow. Wing pads present in both male and female, but larger and more fully developed in the female. In the mature males the front wing pads overlap the hind wing pads only slightly, while in the females the front wing pads may extend back as far as the middle of the hind wing pads.

Abdomen cylindrical; cerci composed of about thirty segments, each of the segments ending in a whorl of hairs. Tenth abdominal tergite of male produced into a prominent protuberance which is longer than in A. recta but not quite as long as in A. pygmaea; in side view the protuberance, as measured from the base of the cercus to the apex, is longer than the ninth tergite, and is directed slightly upwards. The mouth parts are similar in structure to those of A. pygmaea.

Allocapnia vivipara Claassen

Length of body up to 8.5 mm.; antennae up to 4 mm.; cerci up to 3.4 mm.

The nymphal males of this species are readily recognized by

the absence of wing pads.

General color brown with the appendages somewhat lighter in color.

Head slightly wider than pronotum; surface quite smooth, with

a feeble coating of fine hairs; epicranial suture distinct; hind ocelli about twice as close to the eyes as to each other; antennae with about forty-five to forty-six segments.

Pronotum a little longer than wide, widened posteriorly; front angles more narrowly rounded than hind ones. Meso- and metanotum hairy, without wing pads in the male, or with only very small rudiments; female with conspicuous wing pads, although they are rather wide and short.

Abdomen cylindrical. In the male, the tenth tergite is produced into a prominent protuberance which is directed slightly upwards; in dorsal view this protuberance is broadly rounded at the tip but in side view it is rather square at the tip or roughly boot-shaped. In mature nymphs the genital structures of the developing adult may readily be observed. Cerci with twenty-seven to twenty-eight segments.

Frison (6) has guestioned my statement (3), that this species is viviparous. Although I have no experimental evidence to confirm my statement, I have again checked over the material and find that in some of the females there occur fully formed nypmhs, with their bodies completely extended, and measuring 1 mm. in length. Frison suggests "the possibility that the nymphs observed by Claassen in a dissected female were disclosed by the accidental rupture of the egg shell." However, the young nymphs were first noted in the alcoholic female specimens underneath the abdominal wall before any of the specimens had been dissected. In these females the anterior portion of the abdomen contained eggs only while in the posterior part a number of fully developed nymphs could be clearly observed. Dissection dislodged eggs and nymphs and the eggs were not brittle or easily ruptured. Frison found some of the females laving eggs under laboratory conditions and he says "it was found that the embryonic nymphs of this species (vivipara) are in a rather advanced stage when the eggs are laid." Lake Forest, Oakwood, and many other localities in Illinois.

Allocapnia incisura Claassen

Of this species no males have been reared. I have, however, several adults, both males and females, in which some of the females still have the nymphal skin attached to their bodies. These specimens bear the following label: "Adults reared in laboratory, taken from aquaria; 15 Jan. 1909. Larvae collected 20 Dec. 1909, Charleston, Ill. Sta. 57. No. 1201. T. L. Hankinson."

These nymphal skins are in such poor condition that it is impossible to make an adequate description of the nymph.

Allocapnia mystica Frison

The following description of this nymph is taken from Frison (6). Nymphal male.—Similar in general form, color, and structure to A. vivipara. Wing pads conspicuous, fore wing pads overlapping base of hind wing pad. Dorsal lobe-like protuberance at apex of abdomen nearly twice as long from base of anal cerci to apex as length of ninth dorsal segment.

Nymphal female.—Differs from male in being somewhat larger and with apex of abdomen rounded and not with a long protuberance. In some specimens an indication of the projection on the posterior margin of the eighth ventral abdominal segment may be

seen through the integument.

This species has thus far been found only in Illinois.

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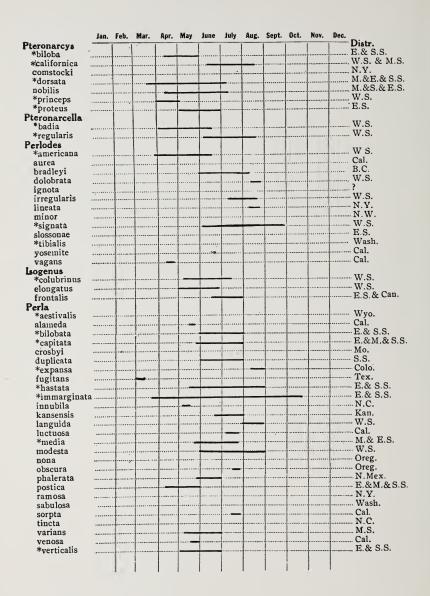
DISTRIBUTION AND EMERGENCE TABLE

THE genera are arranged in the same sequence as they occur in the Monograph of North American Plecoptera (27).

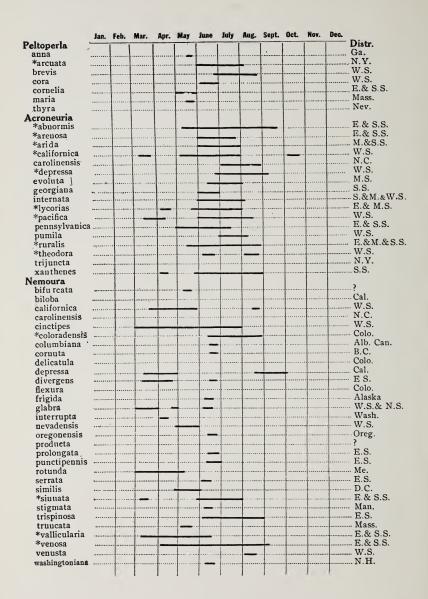
The species of which the nymphs are known, and which are

treated in this paper are marked with an *.

The black lines cover the time at which the various species have been collected in the adult stage. Where no emergence is indicated, the species have been described originally from specimens without date of collection. Under distribution column the following abbreviations are used: E.S. = Eastern states; M.S. = Middle states; S.S. = Southern states; W.S. = Western states; N.W. = Northwestern states; N.S. = Nova Scotia; Can. Rock. = Canadian Rockies. The other abbreviations denote States or Provinces.



	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Alloperla					1	T	<u> </u>	1	<u> </u>	1	F	T	Distr.
albertaensis	•••••				ļ		-		ļ		ļ		Alb.Can.
*borealis *coloradensis	*********		-	-	-	-	_	-	ļ		ļ		W.S.
continua						ļ		 -	ļ				. W.S. Cal.
fidelis							†	······	······		·····		W.S.
imbecilla	***************************************								1				E.& S.S.
*lamba	.,								<u> </u>				Colo.
lateralis		ļ										I	E.& S.S.
lineosa				ļ	ļ		<u> </u>	-	ļ		ļ		w.s.
marginata			ļ	ļ		ļ <u> </u>			ļ		ļ		E.S.
*mediana nanina	•	 		∤ -		1		·	 		ļ		E.& S.S.
novascotiana			ļ	ļ		 		 	·		ļ	·····	E.& S.S. N.S.
pacifica		·····	ļ	·····	ļ					ļ			W.S.
*pallidula		· · · · · ·	·		_	+		†····					W.S.
pilosa	*******	1	1	1					1				Colo.
serrata		1		1		1			1				W. Can.
signata			ļ		ļ			<u> </u>			ļ		. W.S.
*spatulata	••••	ļ			ļ		ļ		ļ			ļ	. Cal.
Chloroperla *cydippe							ļ						E.& S.S.
Paraperla		1		1		1	-	†·····		······			E.& 5.5.
*frontalis			ļ		<u> </u>			-		ļ		ļ	w.s.
Kathroperla perdita		1	1										w.s.
Neoperla	••••••	· · · · · ·		-	_	·······		·	·			ł	. w.s.
*clymene					ļ	_		1					E.&M.&S.S.
Clioperla		1	1		1	1			1				
annecta *clio		+	+	+		·	·	+			·····		
*ebria	••••••				†	_	+ ······	·	†				M.& S.S. W.S.
gravitans	***********	1	1			1	1		1		······		. Wash.
marmorata		ĺ	1	1	Ī	1		1	1				Nev.
*similis		ļ											E.S.
slossonae					ļ	·	ļ	ļ	·	ļ		ļ	N.H.
sobria		· · · · · · · · ·		ł	ł	· 	ł		·····	ļ		·····	· W.S.
Isoperla		1		1			1	1					~ ~
bellona *bilineata	**********	·		·		 	-	·····	·			·····	
fusca		1	1		-	_			1	·····			E.& M.S. Alb. Can.
*5-punctata		1		1	†			1	1				W.S.
longiseta			I										M.S.
marlynia													N.J.
marmona			ļ		ļ		ļ	ļ	1				Utah.
minuta		ļ				ļ	ļ		ļ				M.S.
montana				·	-		-	·····					M.&E.S.
*petersoni		·	†·····	†		†	-	·····	†				Utah.
*signata sordida		······		·			-	· · · · · · · · · · · · · · · · · · ·	ļ				. E.S. . W.S.
ventralis		1		-				1	1				S.S.
Perlesta		T				1					I	1	0.0.
*placida													E &M.&S.S.
Atoperla		1											
*ephyre Perlinella		·····	·	-		-			 	•••••		}	E.S.
*drymo			ļ				ļ		ļ				E.&M.&S.S.
			1		l	1	1	1	1				



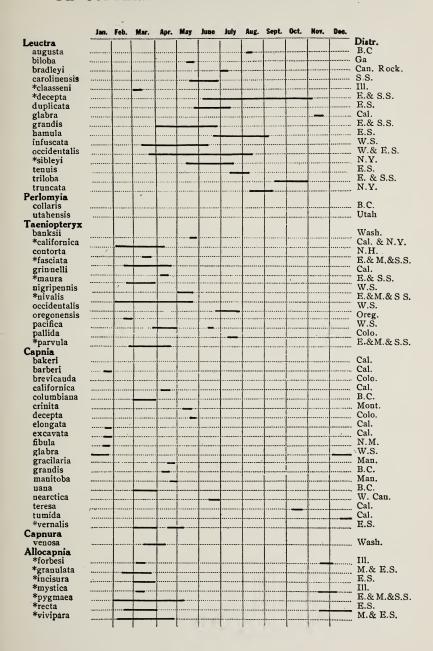


PLATE 1

FIGURES 1-16

- 1- 5 Pteronarcys dorsata Say
 - 1. Labrum
 - 2. and 3. Mandibles
 - 4. Labium
 - 5. Maxillary palpus
- 6-10 Pteronarcys californica Newpt.
- 11-16 Pteronarcys proteus Newm.
 - 15. Front leg
 - In the above species, note the rather short, blunt teeth and the large molar of the mandibles; the four-lobed ligula; the large galea, and the flattened tridentate lacinia of the maxilla.

PLECOPTERA NYMPHS OF NORTH AMERICA 127

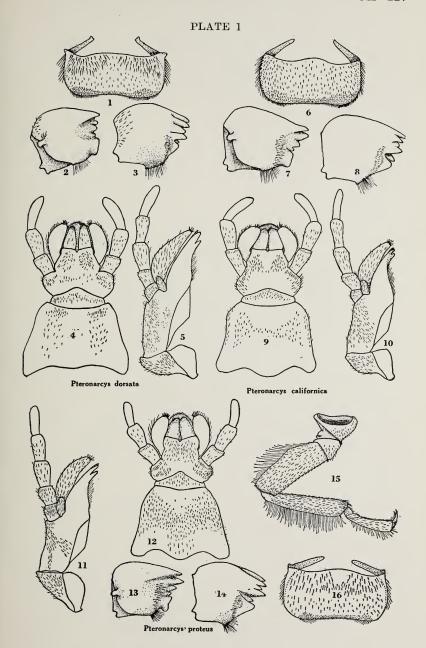


PLATE 2

FIGURES 17-32

- 17-21 Pteronarcys biloba Newm.
- 22-26 Pteronarcella badia Hagen

Note the similarity of structure of the mouth parts of this genus with Pteronarcys.

27-32 Peltoperla arcuata Needham

Note the wide hairy and spiny front leg; the lobe-like appendage of the coxa; the wide short, four-lobed labium; the large galea of the maxillary palpus with a terminal brush of hairs, and the blunt teeth and large molar of the mandibles.

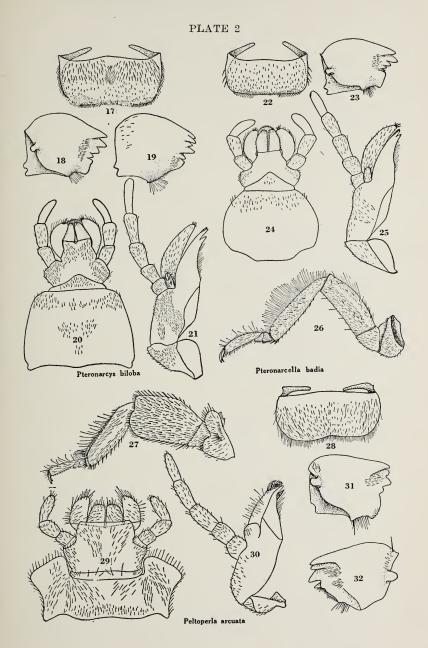


PLATE 3 FIGURES 33-49

33-38 Perla hastata Banks

Note the epipharynx on the labrum; the sharp tooth mandibles without molar, the small glossae and the large paraglossae, each terminating in a spinulose papilla; the slender galea, the bidentate lacinia, and the long cardo and stipes.

39-43 Isogenus colubrinus Hagen

Mouth parts very similar to those of above species

44-49 Perlodes tibialis Banks

The mouth parts of this species are very similar to those of the previous species but the galea is distinctly two-segmented, and the lacinia is quite wide at the base of the terminal teeth.

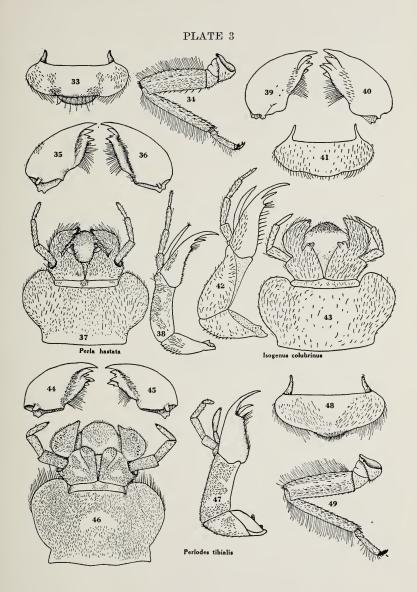
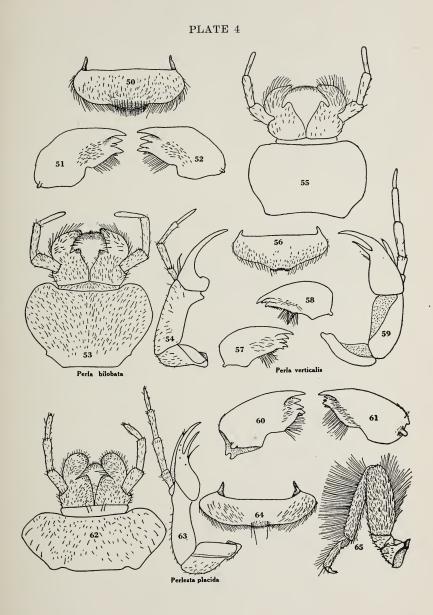


PLATE 4

FIGURES 50-65

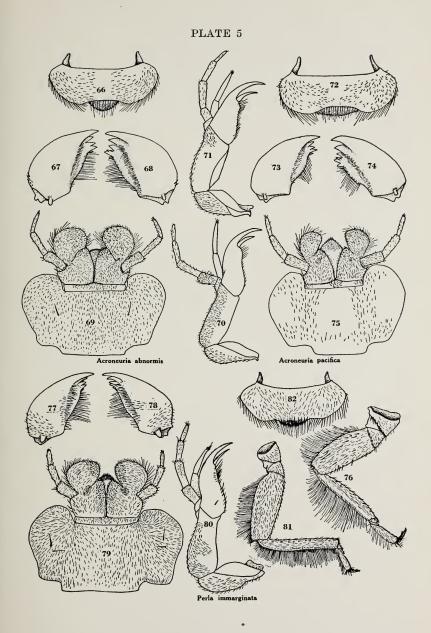
- 50-54 Perla bilobata Ndm. and Clsn.
 - Note the unique structure of the maxilla. The galea is reduced to a very small appendage and the lacinia is smooth and unidentate.
- 55-59 Perla verticalis Banks
 - Mouth parts similar to those of the above species but the galea is a little longer and the lacinia is bidentate and possesses a few hairs.
- 60-65 Perlesta placida Hagen
 - The submentum of the labium is short and wide; the second tooth of the lacinia is followed by a single hair.



FIGURES 66-82

- 66-70 Acroneuria abnormis Newm.
- 71-76 Acroneuria pacifica Banks.
- 77-82 Perla immarginata Say.

The mouth parts of these three species are very similar and do not show characters sufficiently different to be useful in specific determination.



FIGURES 83-99

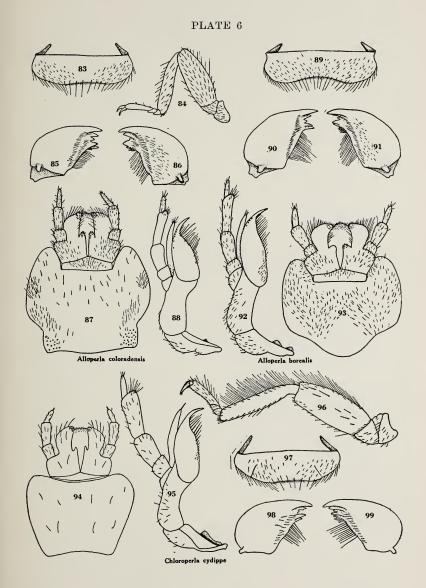
83-88 Alloperla coloradensis Banks

89-93 Alloperla borealis Banks

In the above two species note that the inner apex of the fourth segment of the maxillary palpus is produced and bears a bunch of hairs; the lacinia appears to be unidentate but there is a suggestion of a second small tooth.

94-99 Chloroperla cydippe Newm.

Very similar to the above two species but lacinia is distinctly unidentate; and the submentum is not so much produced at the anterio-lateral areas.



FIGURES 100-116

- 100-105 Paraperla frontalis Banks

 Note the long narrow labium and the lacinia with a long incurved terminal tooth, bearing a small tooth and a "comb" of stiff hairs.
- 106-110 Clioperla clio Newm.

 Note the very wide lacinia; the small galea and the attenuated terminal segments of the maxillary and labial palpi.
- 111-116 Neoperla clymene Newm.

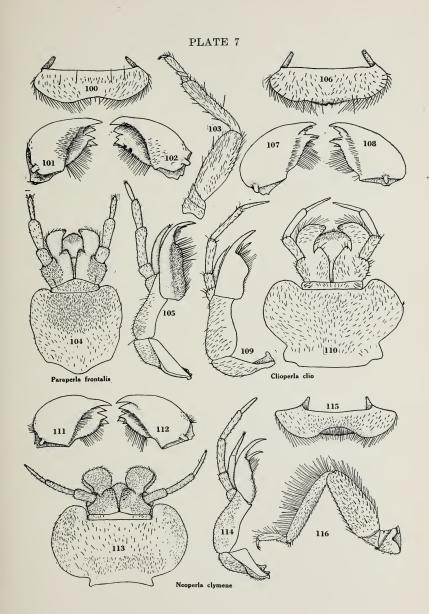
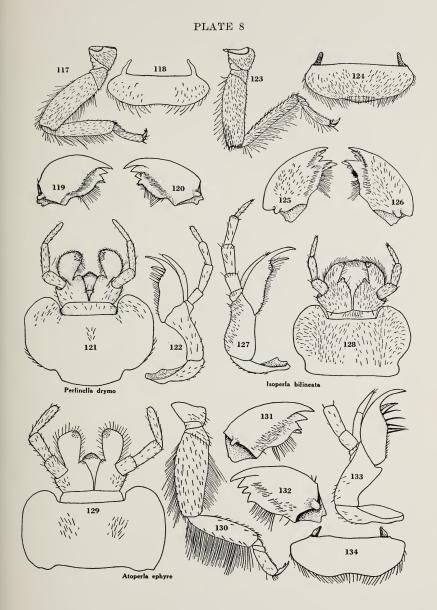


PLATE 8 FIGURES 117-134

117–122 Perlinella drymo Newm. 123–128 Isoperla bilineata Say 129–134 Atoperla ephyre Newm.

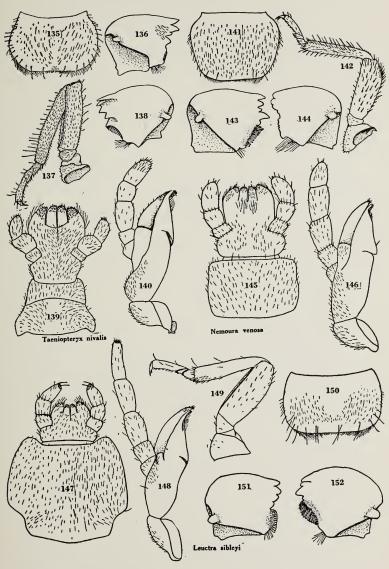


FIGURES 135-152

- 135-140 Taeniopteryx nivalis Fitch 141-146 Nemoura venosa Banks
- 147-152 Leuctra sibleyi Clsn.

All three species are herbivores. The labrum is long and narrow, the mandibles have short, blunt teeth, a large molar and below this a "comb" of stout hairs; the ligula is four-lobed and the suture between the glossae does not extend to the mentum; the galea is stout; the lacinia bears two small terminal teeth and the suture separating the lacinia from the stipes is only partially indicated.





		FIGURES	153-16
153-158	Allocapnia	pygmaea Burm.	

159-163 Capnia vernalis Newpt. Herbivores; galea large, lacinia tridentate.

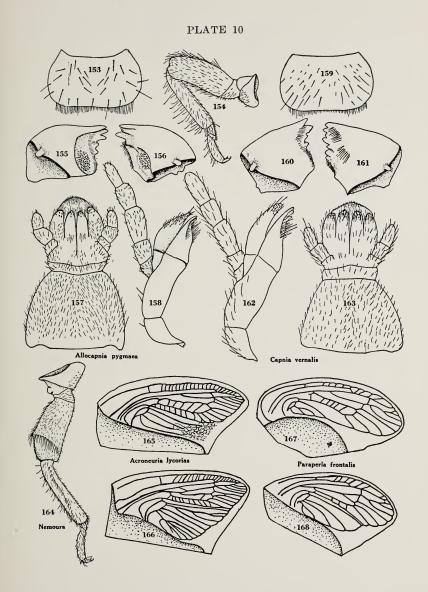
Nemoura sp. 164

165-166 Acroneuria lycorias Newm.

Wing pads showing venation.

167-168 Paraperla frontalis Banks.

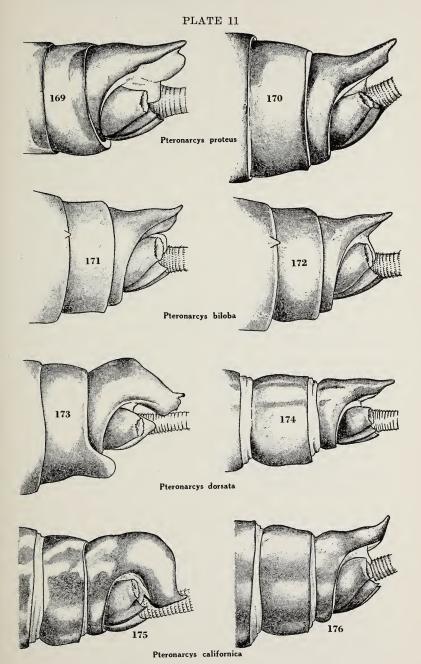
Wing pads showing venation.



FIGURES 169-176

- 169-170 Pteronarcys proteus Newm.

 169. Terminal segments of male nymph
 170. Terminal segments of female nymph
 171 172 Pteronarcys hiloha Newm
- 171–172 Pteronarcys biloba Newm. 171. Male
- 172. Female 173–174 Pteronarcys dorsata Say.
- 173. Male 174. Female
- 175-176 Pteronarcys californica Newpt.
 175. Male
 176. Female



FIGURES 177-184

177–178 Pteronarcella badia Hag. 177. Male

178. Female 179–180 Pteronarcella regularis Hag. 179. Male

 $\begin{array}{cc} & 180. \ \ \text{Female} \\ 181\text{--}182 & Perlodes \ signata \ \ \text{Banks.} \end{array}$

181. Male 182. Female

183-184 Peltoperla arcuata Ndm.

183. Male 184. Female



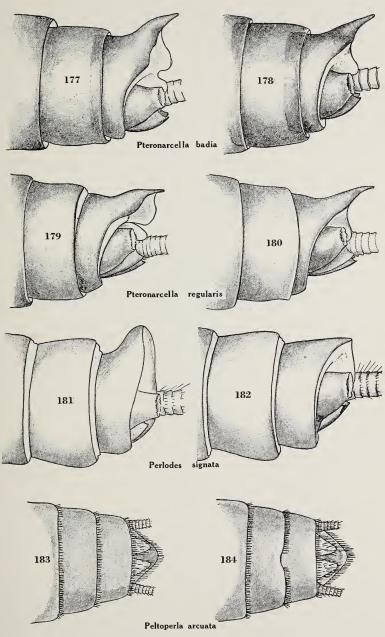
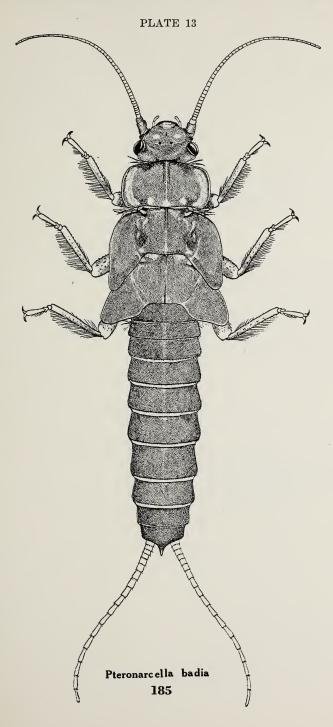


PLATE 13 FIGURE 185

185 Pteronarcella badia Hagen
Inch or less in length; blackish; gills on first three abdominal segments. Western.



FIGURES 186-187

- 186 Peltoperla arcuata Ndm.
 - Dorsal view of nymph.
- 187 Peltoperla arcuata Ndm.
 - Ventral view of nymph.
 - Roach-like; brown; head bent under; pro-, meso- and metanotum very wide; pro-, meso-, and metasterna very large; gills composed of single filaments; cerci very short.

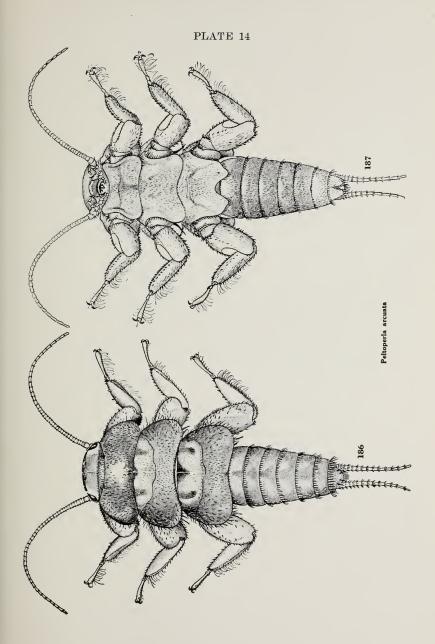


PLATE 15 FIGURES 188-189

- 188 Perla hastata Banks
 Mottled areas on head; huge maxillae; rather square pronotum; color olivaceous; slender legs; no gills.
- 189 Perla verticalis Banks
 Huge maxillae; somewhat square pronotum; no gills; pro- and
 mesonotum yellow in center and blackish all around.

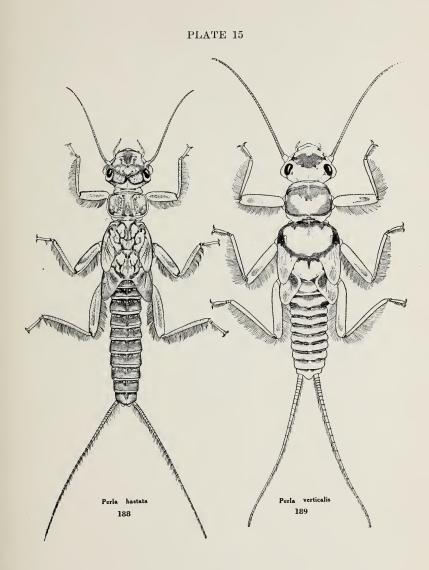
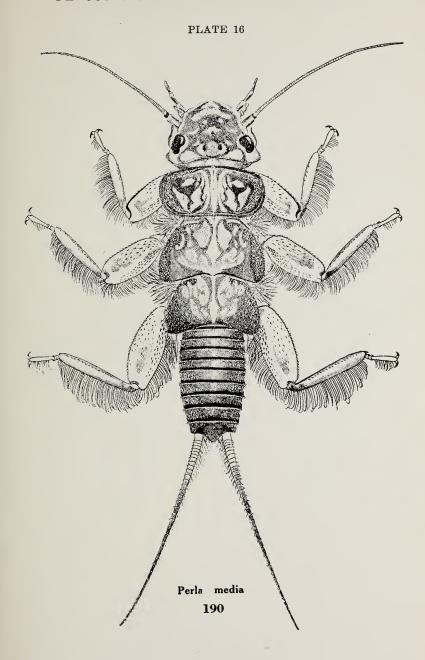


PLATE 16 FIGURE 190

190 Perla media Walker

Short, broad, flattened; dark brown to blackish; hairy and usually with a dirty appearance; strong occipital ridge; very heavy fringes of long hairs on legs; abdomen quite uniformly brown.



FIGURES 191-192

- 191 Alloperla spatulata Needham and Claassen
- 192 Alloperla borealis Banks

Wide rounded wing pads; short cerci; legs sparsely fringed; no gills; yellowish color; body cylindrical.

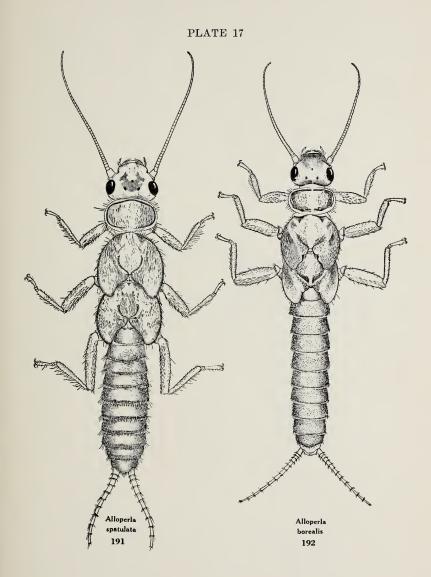
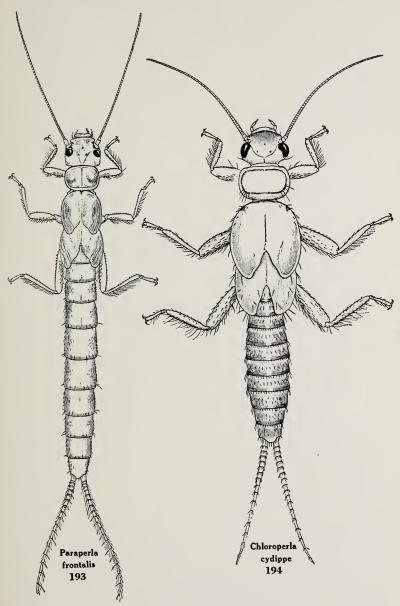


PLATE 18 FIGURES 193-194

- 193 Paraperla frontalis Banks
 Long slender body; head rather square; small eyes set far forward; oval pronotum; no gills.
- 194 Chloroperla cydippe Newman Wide rounded wing pads; short cerci; no gills; yellowish.





FIGURES 195-196

- 195 Neoperla clymene Newman
 - Two ocelli set close together; thoracic and anal gills; abdomen transversely banded.
- transversely banded. 196 *Clioperla clio* Newman
 - No gills; front wing pads straight or sinuate; palpi attenuated to sharp points.

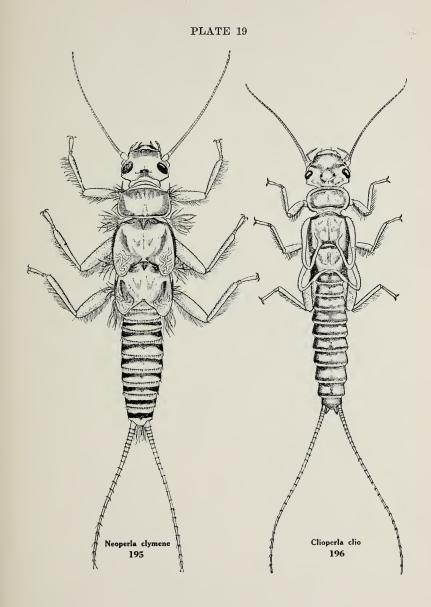


PLATE 20 FIGURES 197-198

- 197 Isoperla petersoni Claassen
 - Wing pads lacking or very short; wide median yellow stripe with a narrower yellow stripe each side of the abdomen.
- 198 Isoperla signata Banks
 - Yellow pronotum, bordered with black; yellow spot between hind ocelli; banded abdomen.

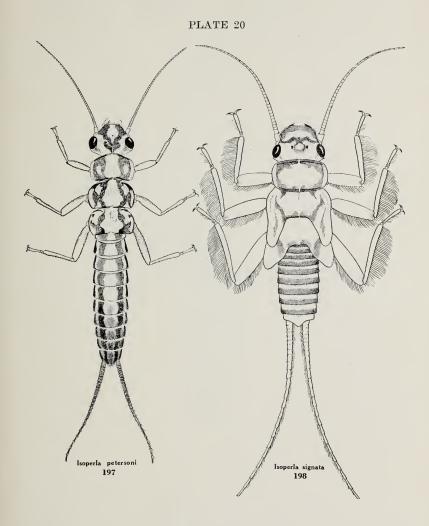


PLATE 21 FIGURE 199

199 Perlesta placida Hagen
Broad rounded wing pads; body freckled; anal gills.

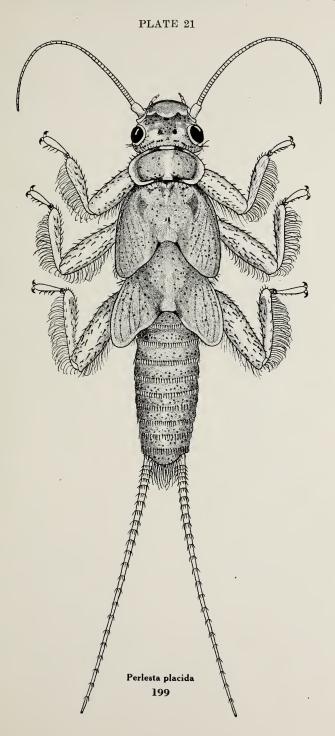


PLATE 22 FIGURES 200-201

- 200 Atoperla ephyre Newman

 Two ocelli, spaced considerably apart; oval pronotum; long tufted gills; long fringes on legs.
- 201 Perlinella drymo Newman

 Long gills under thorax; small anal gills; eyes set far forward on head.

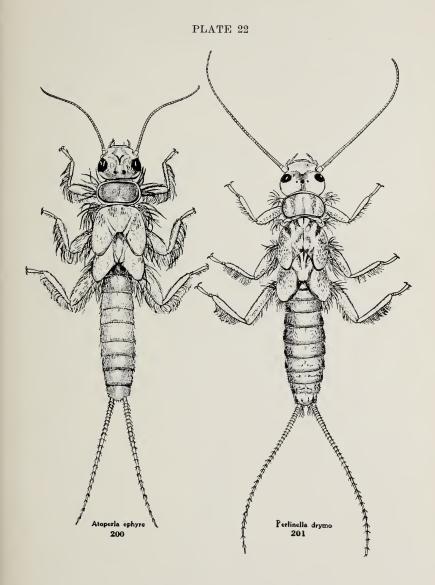


PLATE 23 FIGURE 202

202 Acroneuria arida Hagen Striking color pattern; wide pronotal flange; anal gills; abdomen quite uniformly brown.

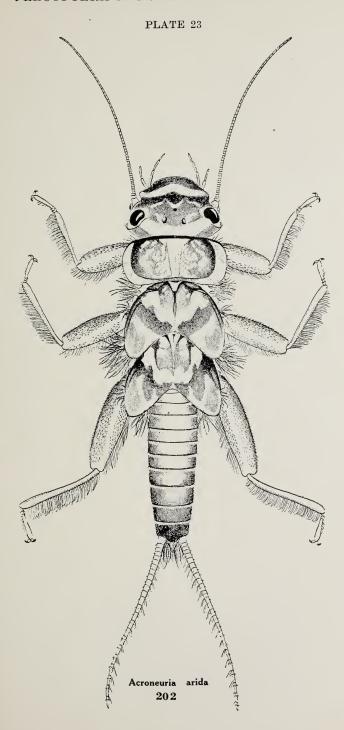


PLATE 24 FIGURE 203

203 Acroneuria ruralis Hagen Yellowish; wavy occipital ridge; wide pronotal flange; cerci as long or longer than body.

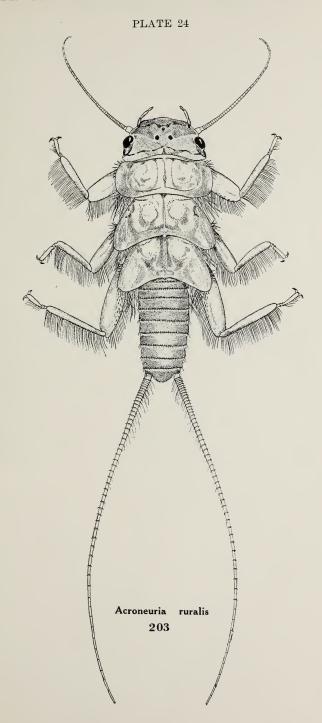
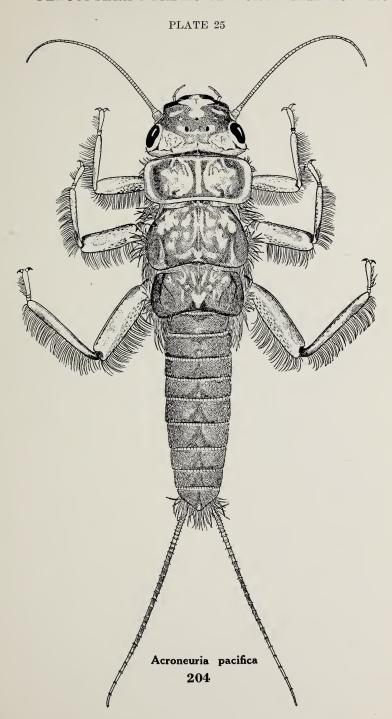


PLATE 25 FIGURE 204

204 Acroneuria pacifica Banks
Blaze on front of head; wide pronotum; very copious anal gills.
Western.



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PLATE 26 FIGURES 205-206

- 205 Acroneuria californica Banks
 Yellow spot over ocellar triangle; color pattern clear cut; no anal gills.
- 206 Acroneuria theodora Needham and Claassen
 Dark over ocellar triangle.

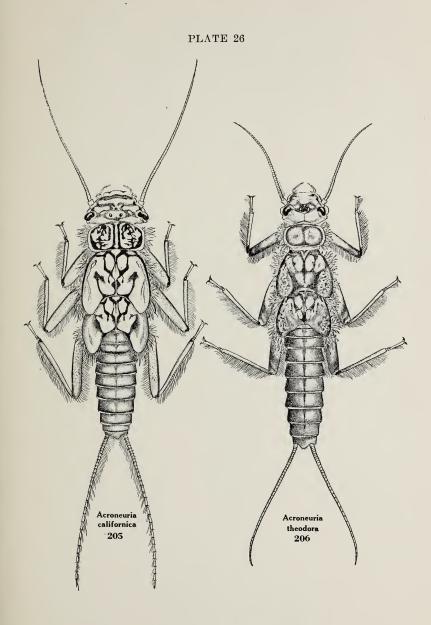
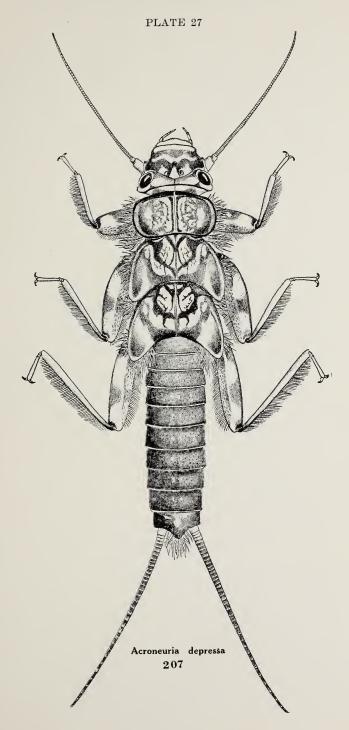


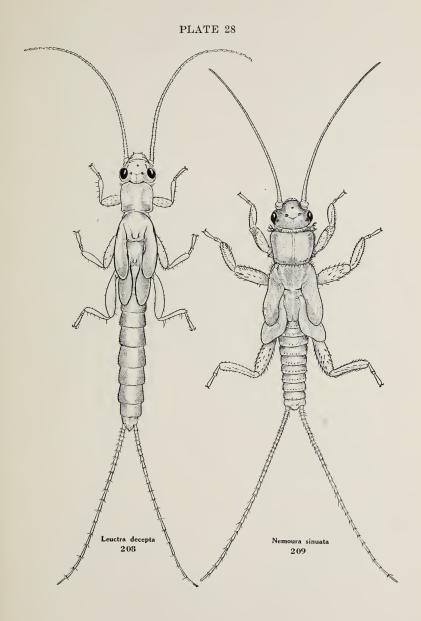
PLATE 27 FIGURE 207

207 Acroneuria depressa Needham and Claassen
Distinct occipital ridge; anal gills; yellow mark between hind occili.



FIGURES 208-209

- 208 Leuctra decepta Claassen
 - Long slender body; wing cases long, narrow and parallel to the body; sparsely clothed with hairs; no gills.
- 209 Nemoura sinuata Wu
 - Stocky body; pronotum fringed with stout hairs; cervical gills; hind wing pads diverging from body.



FIGURES 210-216

- 210 Taeniopteryx nivalis Fitch
 Yellow stripe along body; diverging wing pads; coxal three-segmented gills; cerci and antennae long.
- 211 Nemoura vallicularia Wu (after Wu)

 Tracheal system of nymph, showing also tufts of peripheral tracheoles.
- 212 Prosternal gills and their attachment to the trachea in N. venosa Bks. (after Wu)
- 213 Prosternal gills of N. venosa Bks. (after Wu)
- 214 Prosternal gills of N. sinuata Wu (after Wu)
- 215 Male, Taeniopteryx fasciata Burm.
- 216 Female, Taeniopteryx fasciata Burm.

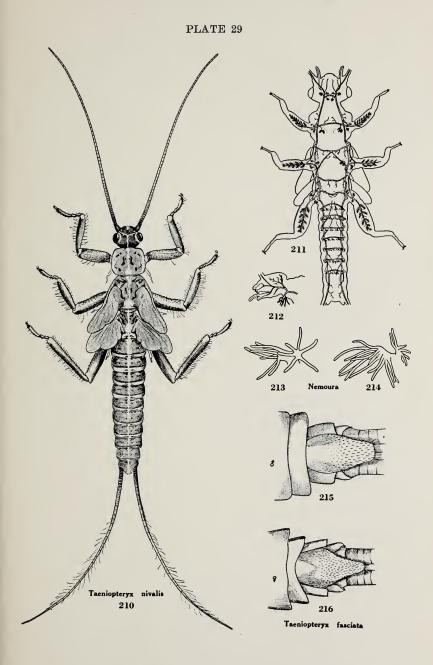


PLATE 30 FIGURES 217-218

- 217 Capnia vernalis Newport
 Small blackish nymphs; anal field of hind wing pads not extending much beyond middle.
- 218 Allocapnia pygmaea Burmeister
 Small blackish; anal field of hind wing pads extending beyond middle.

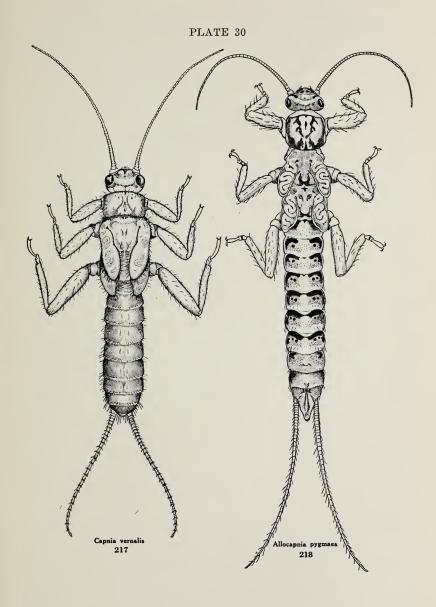


PLATE 31 Figures 219-222

219 Perla immarginata Say

Light spot in ocellar triangle; longitudinal dark stripes on femora; basal half of abdominal tergites dark; last abdominal tergite with an inverted V-shaped notch; prominent occipital ridge. No caudal gills.

220 Perla capitata Pictet

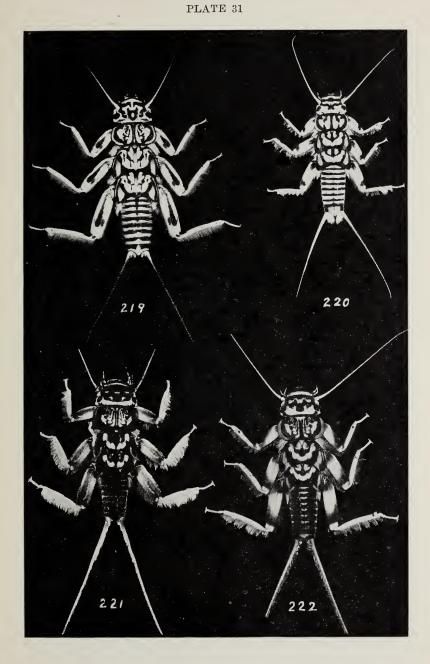
Wavy, dark, transverse band on head through ocellar triangle; femora with dark blotches or bands at both ends; caudal half of abdominal tergites dark, except the last which is dark on sides only; prominent occipital ridge; caudal gills present.

221 Acroneuria abnormis Newman

Dark, hairy; five, more or less distinct, small light spots on head; abdomen uniformly dark; legs and cerci with long thick fringes of hairs; occipital ridge and anal gills absent.

222 Acroneuria lycorias Newman

Resembles *P. capitata* but lacks the occipital ridge and anal gills; caudal half of abdominal segments dark, basal half more or less yellow.

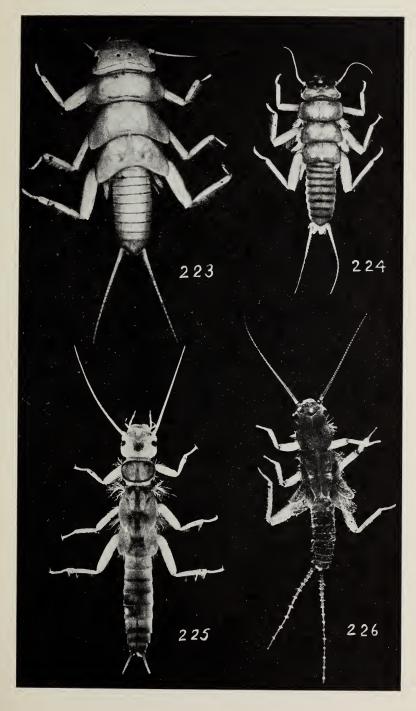


FIGURES 223-226

- 223 Acroneuria ruralis Hagen

 Nearly uniformly yellowish brown; occipital ridge present; wide
 pronotal flanges; cerci as long as, or longer than body; no caudal
 gills.
- 224 Acroneuria pacifica Banks
 Blaze or white elongate mark in front of anterior ocellus; body
 nearly concolorous; copious anal gills; Western.
- 225 Perlinella drymo Newman
 Long head; small eyes; oval pronotum; very long gills; wing pads
 with rounded sides; anal gills absent.
- 226 Nemoura sinuata (?) Wu
 Uniformly brown, spiny and stocky body; gills at throat; hind wing
 pads diverge greatly from body.

PLATE 32



FIGURES 227-230

- 227 Acroneuria arida Hagen Striking color pattern; wide pronotal flange; occipital ridge absent; small anal gills; abdomen nearly uniformly brown.
- 228 Perla media Walker
 Short, broad flattened; dark brown to blackish; hairy and usually with a dirty appearance; heavy fringes of long hairs on legs; abdomen brown.
- 229 Taeniopteryx nivalis Fitch
 Light strip on body; diverging wing pads; coxal three-segmented gills; very long slender antennae and cerci.
- 230 Perla hastata Banks
 Mottled areas on head; large maxillae; rather square pronotum; color olivaceous; slender legs; no gills.

PLATE 33

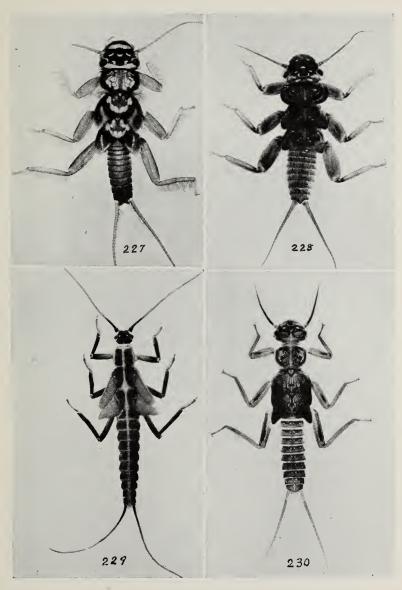
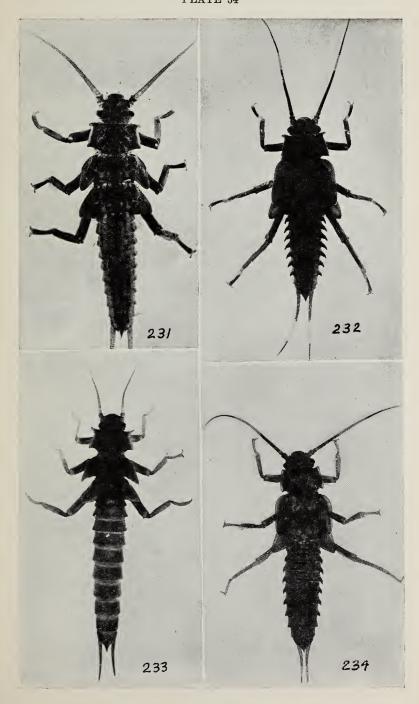


PLATE 34 Figures 231-234

- 231 Pteronarcys dorsata Say
 - Dark brown, sometimes striped; angles of pronotum not much produced; wing pads rather broadly rounded; abdominal segments without spines or hooks; antennae and cerci not banded with yellow.
- 232 Pteronarcys biloba Newman
 - Antennae and cerci with a yellow band near the middle; angles of pronotum quite sharp; hooks on abdominal segments large and directed away from body; cerci half or more than half as long as abdomen.
- 233 Pteronarcys californica Newport
 - Angles of pronotum produced into sharp processes; wing pads sharply pointed; abdominal segments smooth; antennae and cerci quite short and without lighter bands.
- 234 Pteronarcys proteus Newman
 - Angles of pronotum not produced; hooks on abdominal segments appressed; antennae and cerci with light bands near the middle; cerci less than half as long as abdomen.

PLECOPTERA NYMPHS OF NORTH AMERICA 193 PLATE 34

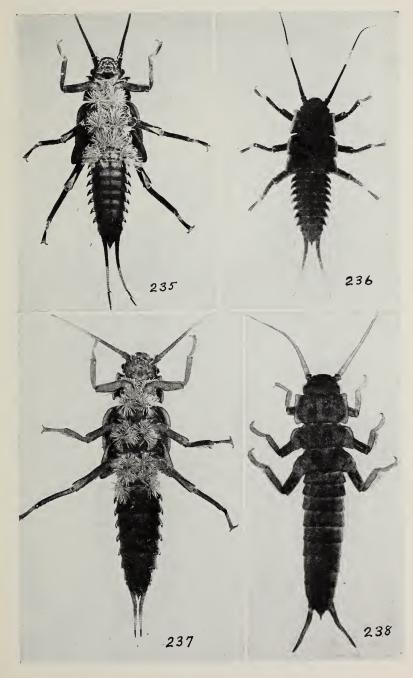


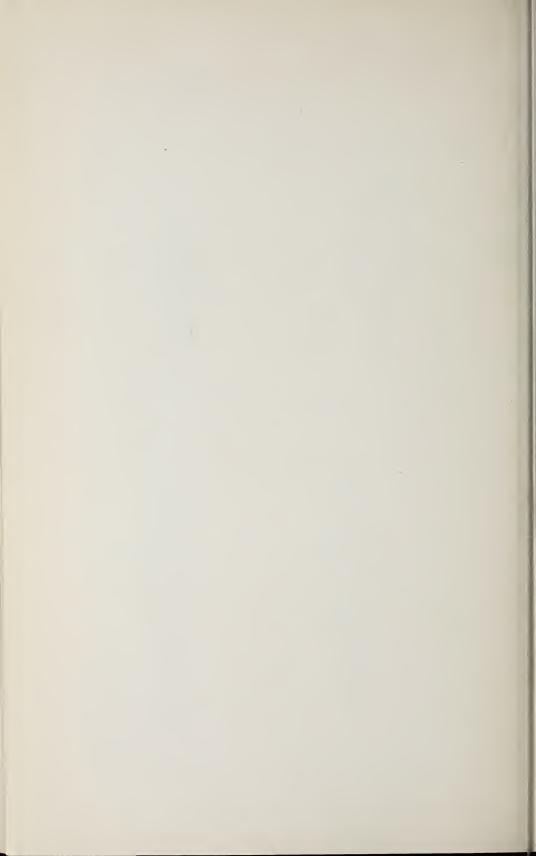
FIGURES 235-238

- 235 Pteronarcys biloba Newman
 - Ventral view showing gills.
- 236 Pteronarcys biloba Newman Young nymph. Note the light lateral margins of the thorax.
- 237 Pteronarcys proteus Newman Ventral view.
- 238 Pteronarcys princeps Banks

Pronotum rather square; angles hardly produced; abdomen smooth; antennae and cerci banded with yellow. Western.

PLATE 35





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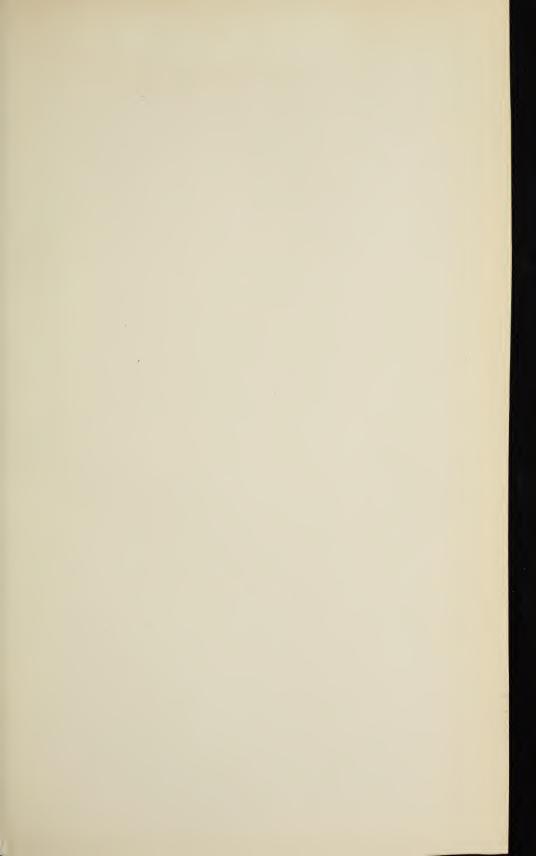
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